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# Rio Blanco Oil Shale Company

## MODULAR DEVELOPMENT PHASE
## MONITORING REPORT ELEVEN

Volume 1 of 2

**January – December 1982**

**Year End Report**

Gulf Oil Corporation / Standard Oil Company (Indiana)
'A General Partnership'
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# RIO BLANCO OIL SHALE COMPANY
# MODULAR DEVELOPMENT PHASE
# MONITORING REPORT 11

January 1982 - December 1982

YEAR-END REPORT

Prepared by:
RIO BLANCO OIL SHALE COMPANY
AURORA, COLORADO

April 30, 1983

TABLE OF CONTENTS


| Section | Title | Page |
|---|---|---|
| 1 | INTRODUCTION | 1-1 |
| 2 | ATMOSPHERIC STUDIES | |
| 2.0 | Introduction | 2-1 |
| 2.1 | Air Quality | 2-3 |
| 2.2 | Meteorology | 2-30 |
| 2.3 | Climatology | 2-60 |
| 2.4 | Quality Assurance and Data Recovery | 2-69 |
| 2.5 | Visibility | 2-73 |
| 2.6 | Noise | 2-85 |
| 2.7 | Summary | 2-92 |
| 3 | TERRESTRIAL | |
| 3.0 | Introduction | 3-1 |
| 3.1 | Vegetation, Range, and Browse | 3-3 |
| 3.2 | Fauna | 3-41 |
| 3.3 | Summary | 3-49 |
| 4 | AQUATIC STUDIES | |
| 4.0 | Introduction | 4-1 |
| 4.1 | Abiotic Components | 4-4 |
| 4.2 | Biotic Components | 4-25 |
| 4.3 | Summary | 4-52 |
| 5 | HYDROLOGY STUDIES | |
| 5.0 | Introduction | 5-1 |
| 5.1 | Dewatering/Reinjection/Discharge Program | 5-3 |
| 5.2 | MIS Modular Development Area | 5-26 |
| 5.3 | Summary | 5-77 |
| 6 | SPECIAL STUDIES/ECOLOGICAL INTERRELATIONSHIPS | |
| 6.0 | Introduction | 6-1 |
| 6.1 | Revegetation | 6-3 |
| 6.2 | Mule Deer Habitat Modification Study | 6-49 |
| 6.3 | Shrub Growth Enhancement on a Simulated Mine Site and/or Disposal Pile Bench | 6-54 |
| 6.4 | Study to Alter Natural Succession After Fire for Enhanced Deer-Livestock Forage | 6-60 |
| 6.5 | Run-of-Mine Lysimeter | 6-64 |
| 6.6 | Special Meteorological Investigations | 6-69 |
| 6.7 | Comparison Study of Inhalable and Total Suspended Particulates | 6-78 |
| 6.8 | Yellow Creek Stream Classification Study | 6-81 |
| 6.9 | Toxicology | 6-94 |
| 6.10 | Summary | 6-96 |

# LIST OF APPENDICES

## Volume 1

| Appendix | Title |
|---|---|
| 2-0 | Atmospheric Studies |
| 2-1 | Air Quality Data |
| 2-1.1 | Plots of Gaseous Constituents Data at Site 1 |
| 2-1.2 | Total Suspended Particulate Data - Sites 1, 2, and 3 |
| 2-2 | Meteorological Data |
| 2-2.1 | Plots of Meteorological Data at Site 1 |
| 2-2.2 | Plots of Meteorological Data at Site 2 |
| 2-2.3 | Precipitation Data |
| 2-2.4 | Snow Depth Data |
| 2-2.5 | Barometric Pressure Data |
| 2-6 | Visibility Data |
| 2-6.1 | Hourly Visual Range Data - Spring 1982 |
| 2-6.2 | Visibility Site Log Sheets - Spring 1982 |
| 2-6.3 | Hourly Visual Range Data - Fall 1982 |
| 2-6.4 | Visibility Site Log Sheets - Fall 1982 |
| 3-0 | Terrestrial Studies |
| 3-1 | Vegetation Data and Analyses |
| 3-1.1 | Analyses for Browse Utilization Data |
| 3-1.2 | Analyses for Phytosociological Data |
| 3-1.3 | Range Production and Utilization Data |

LIST OF APPENDICES (Continued)

Volume 1 (Continued)

| Appendix | Title |
|---|---|
| 3-1.4 | Analyses for Range Production and Utilization Data |
| 3-2 | Mule Deer Studies |
| 3-2.1 | 1982 Summer Mule Deer Pellet Group Data |
| 3-2.2 | Analyses for Mule Deer Studies |
| 3-2.3 | Mule Deer Road Kill Studies |
| 3-2.4 | Feral Horse Observations During 1982 |

LIST OF APPENDICES (Continued)

Volume 2


| Appendix | Title |
|---|---|
| 4-0 | Aquatic Studies Program |
| 4-1 | Abiotic Data |
| 4-1.1 | Stream Physical and Habitat Characterization Data April, July, and October 1982 |
| 4-1.2 | Stepwise Discriminant Analysis on Stream Physical Measurements at the Aquatic Stations 1982 |
| 4-1.3 | Analysis of Variance (Duncan's Multiple Range Tests) Results for the Stream Physical Data 1982 |
| 4-1.4 | Stream Water Chemistray Data April, July, and October 1982 |
| 4-1.5 | Stepwise Discriminant Analysis Stream Water Chemistry Data |
| 4-1.6 | Analysis of Variance (Duncan's Multiple Range Tests) Results for the Stream Water Chemistry Data 1982 |
| 4-2 | Biotic Data |
| 4-2.1 | Periphyton Enumeration Data Spring, Summer, and Fall 1982 |
| 4-2.2 | Density and Station Occurrence of Periphyton Sampled in 1982 |
| 4-2.3 | Periphyton Density and Diversity Estimates for the 1982 Sampling Season |
| 4-2.4 | Duncan's Multiple Range Analyses for Periphyton Density Evaluations |
| 4-2.5 | Benthic Macroinvertebrate Data Spring, Summer, and Fall 1982 |

LIST OF APPENDICES (Continued)

Volume 2 (Continued)


| Appendix | Title |
|---|---|
| 4-2.6 | Density and Station Occurrence of Benthic Macroinvertebrates Sampled in 1982 |
| 4-2.7 | Benthic Macroinvertebrate Density and Diversity Estimates for the 1982 Sampling Season |
| 4-2.8 | Duncan's Multiple Range Analyses for Benthic Macroinvertebrate Density Evaluations |
| 5-0 | Hydrology Studies |
| 5-1.1 | 1982 Water Quality Data Listing (Alluvial Aquifers, Development Activities Monitoring, Springs and Seeps, and Upper Aquifer) |
| 5-1.2 | 1982 Field Measurements Data (Development Activities Monitoring, and Springs and Seeps) |
| 5-1.3 | 1982 Field Measurements Data (Alluvial Aquifers, Lower Aquifer, and Upper Aquifer) |
| 5-1.4 | 1982 Water Quality MANOVA Results (Dewatering/Reinjection System, and MIS Development Area) |
| 5-2.1 | 1982 Water Year USGS Data (Stream Gage Sites) (Daily Values Time Series, Water Quality Data Listing, and Duncan's Multiple Range Test Restuls - Daily Mean Flow and Conductivity) |
| 6-0 | Special Studies/Ecological Inter-relationships |
| 6-1 | Experimental Revegetation Data and Analyses |

LIST OF APPENDICES (Continued)

Volume 2 (Continued)

| Appendix | Title |
|---|---|
| 6-1.1 | Plot R-1 Experimental Revegetation Data |
| 6-1.2 | Analyses for Plot R-1 Experimental Revegetation Data |
| 6-1.3 | Plot R-2 Experimental Revegetation Data |
| 6-1.4 | Analyses for Plot R-2 Experimental Revegetation Data |
| 6-1.5 | Plot R-3 Experimental Revegetation Data |
| 6-1.6 | Analyses for Plot R-3 Experimental Revegetation Data |
| 6-2 | Mule Deer Habitat Modification Studies |
| 6-2.1 | Mule Deer Habitat Modification Studies Data |
| 6-2.2 | Analyses for Mule Deer Habitat Modification Data |

# SECTION 1
# INTRODUCTION

# 1.0 INTRODUCTION

The United States Department of the Interior/Geological Survey (USGS) initiated planning in 1969 for a prototype oil shale leasing program. Under this program, Gulf Oil Corporation and Standard Oil Company (Indiana) acquired the rights to Federal Oil Shale Lease Tract C-a in the Piceance Basin in northwest Colorado in 1974. These two companies are developing Tract C-a under a general partnership called the Rio Blanco Oil Shale Company (RBOSC).

RBOSC has been engaged in extensive environmental data collection programs since its inception in 1974. Environmental baseline data were gathered between October 1974 and September 1976. An interim environmental monitoring program was conducted between September 1976 and August 1977, the period during which the Tract C-a lease was suspended. RBOSC initiated the Modular Development Phase (MDP) of tract development and the MDP Environmental Monitoring Program in August of 1977.

The MDP Environmental Monitoring Program is designed to provide data on air quality, meteorology, visibility, terrestrial ecology, aquatic ecology, hydrology, and specialized topics including ecological interrelationships. The program is designed based on the environmental stipulations in the Tract C-a lease, analysis of baseline and interim monitoring data, assessment of probable development impacts, and inputs from the Mineral Management Service Oil Shale Office (OSO). Monitoring is conducted according to the MDP Environmental Monitoring Program Scope of Work (SOW), the current version of which (Revision 6.1) is dated February 25, 1981 and was approved by the OSO May 1, 1981, with subsequent modifications in 1982 to reflect diminished MDP activities and lease suspension.

Data collected through the MDP Environmental Monitoring Program are reported semi-annually, in a mid-year and a year-end report to the OSO. The first MDP monitoring report (Modular Development Phase Environmental Monitoring Report One or MDP 1) was published in February 1978. Subsequent reports were published in September 1978, March and August 1979, March and

August 1980, March and August 1981, and April and September 1982. This report is the eleventh MDP Monitoring Report (MDP 11), and is the fifth year-end report. The MDP 11 report covers the 1982 reporting year (January 1 - December 31, 1982). The report contains presentations and summaries of 1982 data; statistical comparisons between seasons, years, and locations; and assessment of any development-related impacts. Sections of the report generally address objectives, methods, results and discussion, and summary and conclusions. Methods are referenced rather than fully described unless they are different from those employed in previous monitoring periods, need clarification, or have not been previously reported.

Major responsibility for implementation of the MDP monitoring program and preparation of the MDP reports rests with the staff of the RBOSC Environmental Affairs Department. Several other individuals and entities assisted in monitoring activities during the 1982 reporting period and in preparation of MDP 11, however. They include the following:

The Industrial Company (TIC) (Operational Hydrology Monitoring)

Chadwick and Associates (Aquatic Ecology Sample Analysis and Report Preparation)

U.S. Geological Survey (Surface Water Gaging Station Data)

Cathedral Bluffs Shale Oil Company (Visibility Monitoring)

Volume one of MDP 11 contains the following major sections:

| | |
|---|---|
| Section 1 | Introduction |
| Section 2 | Atmospheric Studies |
| Section 3 | Terrestrial Studies |
| Section 4 | Aquatic Studies |
| Section 5 | Hydrology Studies |
| Section 6 | Special Studies/Ecological Interrelationships |

Volume two of MDP 11 contains the following appendices:

| | |
|---|---|
| Appendix 2 | Air Quality and Meteorological Data |
| Appendix 3 | Vegetation and Fauna Data and Analyses |
| Appendix 4 | Aquatic Abiotic and Biotic Data and Analyses |
| Appendix 5 | Hydrological Data and Analyses |
| Appendix 6 | Experimental Revegetation Data and Analyses |

# SECTION 2
# ATMOSPHERIC STUDIES

## 2.0 INTRODUCTION

The Tract C-a atmospheric studies program consists of two elements: (1) measurements of total suspended particulate matter and certain gaseous chemical compounds, and (2) measurements of selected meteorological parameters. The monitoring locations were originally established to measure the ambient air quality generally upwind and somewhat removed from the expected tract development, and at points where tract developments might have an effect on the air quality. Simultaneous meteorological measurements are being made to allow for the prediction of the dispersion of emissions resulting from tract development.

Air quality and meteorological data have been obtained since February 1975 from monitoring instruments located on or near Tract C-a. Data collected during the first two years of monitoring make up the baseline data set. Data from the baseline period were obtained at four locations around the tract. Following the baseline period, an interim data acquisition program was established to cover an interval during which the tract development lease conditions were modified and partially suspended. During the interim period (February through August 1977), a single air quality and meteorological monitoring station was operated to maintain data continuity. The system was expanded to three meteorological and two air quality monitoring stations for the active modified in situ (MIS) retorting stage of the Modular Development Phase.

Following completion of the Modified In-Situ retorting program, the level of activity on the tract has been decreased to a very low level. The monitoring program has been reduced accordingly, and is essentially measuring background conditions. One air quality and two meteorological monitoring sites were maintained throughout 1982 (Table 2-1), but this will be reduced to a single air quality and meteorological monitoring site in 1983.

Table 2-1. Air Studies Monitoring Parameters and Schedule for 1982, Tract C-a

| Parameter | Location | Start Date | Frequency |
|---|---|---|---|
| Sulfur Dioxide | Site 1 | Feb. 1975 | Continuous |
| Hydrogen Sulfide | Site 1 | Feb. 1975 | Continuous |
| Nitric Oxide | Site 1 | Feb. 1975 | Continuous |
| Nitrogen Oxides | Site 1 | Feb. 1975 | Continuous |
| Ozone | Site 1 | Feb. 1975 | Continuous |
| Carbon Monoxide | Site 1 | Feb. 1975 | Continuous |
| Total Suspended Particulates | Sites 1, 2, 3 | Feb. 1975 | Every 3rd day |
| Wind speed (10m) | Sites 1, 2 | Feb. 1975 | Continuous |
| Wind speed (60m) | Site 1 | Feb. 1975 | Continuous |
| Wind direction (10m) | Sites 1, 2 | Feb. 1975 | Continuous |
| Wind direction (60m) | Site 1 | Feb. 1975 | Continuous |
| Wind sigma | Sites 1, 2 | Sept. 1980 | Continuous |
| Ambient temperature (10m) | Sites 1, 2 | Feb. 1975 | Continuous |
| Temperature differential (10-60m) | Site 1 | Feb. 1975 | Continuous |
| Precipitation | Sites 1, 2, 3 | Feb. 1975 | By event |
| Snow depth and accumulation | Sites 1, 2, 3 | Nov. 1978 | By event |
| Solar radiation | Site 1 | Feb. 1975 | Continuous |
| Dewpoint (10m) | Site 1 | July 1978 | Continuous |
| Visibility | Visibility Shelter | Spring 1978 | Semi-annual |
| Noise | 16 locations on tract | Jan. 1978 | Quarterly |

## 2.1 AIR QUALITY

Air quality monitoring is being conducted on and near Tract C-a to measure the concentrations of certain pollutants which may be emitted by tract operations. The ambient air quality monitoring network consists of one location where gaseous constituents are measured (Site 1) and three locations where total suspended particulate (TSP) concentrations are measured (Sites 1, 2, and 3). Sites 1 and 2 are located just west and southwest, respectively, of the tract and generally measure background ambient air quality, while Site 3 is located east of the tract in a broad gulch that drains much of the tract. Under the minimum activity conditions of the lease suspension period, Site 3 will also measure primarily background particulate concentrations.

All of the air quality data, with the exception of the TSP data, are collected by automatic monitoring equipment and recorded by a data acquisition system on digital computer tape and backup strip charts. The data on the digital tape are recorded as hourly values. Hi-Vol monitors are used to collect 24-hour samples of TSP concentrations every third day.

A visibility study (in cooperation with Federal Oil Shale Lease Tract C-b) has been conducted each spring and fall since 1978 as part of the air studies program. In 1979, an addition was made to the study by measuring the visual range with a telephotometer as well as with the traditional photometric technique. This addition will allow comparisons to be made between the two measurement techniques.

Plots of air quality data collected during 1982 are presented in Appendix 2-1.1.

As part of the year-end report, an extensive analysis has been carried out on the data obtained in 1982. Comparisons have been made among the current year, the baseline period (February 1975-January 1977), and the four previous years of the MDP period (1978, 1979, 1980 and 1981).

When analyzing a data set, it is important to evaluate the data in relation to the limitations of the instrumentation. This is particularly true of air quality data gathered in a pristine environment such as Tract C-a. Ambient concentrations of several gaseous constituents usually are at or below the minimum measurement capability of air quality monitoring instruments. Statistical analyses may therefore not be applicable to these data sets.

A quantitative measure has been developed to use as a conservative minimum level, below which there is essentially no probability that the values represent real and valid data. This level, called the threshold of detection, is defined as twice the noise level of the instrument. The threshold of detection can thus be used to determine if there is a sufficient number of valid data points to warrant further statistical analyses.

It should be emphasized that the threshold of detection is a conservative measure to use in determining data validity. It is designed to take into account the errors or uncertainties which develop when measurements are taken near the minimum detectable limit of any monitor. These uncertainties are extremely difficult to quantify, but it is quite likely that the threshold of detection as defined above represents the instruments and data acquisition system in an optimal condition. Consequently, this value, determined independently for each instrument, is a conservative measure of data validity. That is, some data that are not significant (within the noise of the measurement system) may be retained, but no valid data will be arbitrarily discarded (due to a detection limit set too high).

The ultimate goal is to define confidence limits around the data collected by each instrument, which will serve as realistic criteria with which to judge the validity of the data. Threshold of detection values for each instrument are given in Table 2-2. These detection limits can be used as a guide to determine how much of the data can be considered valid for statistical analysis. The significance of the data for each parameter will be discussed separately in the appropriate sections below. In several

Table 2-2. Air Quality Instrumentation used at Tract C-a, with the Threshold of Detection for each Monitor

| Parameter | Manufacturer | Model | Technique | Threshold of Detection (ppm) |
|---|---|---|---|---|
| $SO_2$ | Thermo Electron Corporation | 43 | Pulsed Fluorescence | 0.002 |
| $H_2S$ | Thermo Electron Corporation | 45 | Pulsed Fluorescence | 0.002 |
| $NO/NO_x$ | Bendix | 8101-B | Chemiluminescence | 0.005 |
| Photochemical Oxidant ($O_3$) | Bendix | 8002 | Chemiluminescence | 0.001 |
| CO | Bendix | 8501-5CA | Nondispersive infrared detection | 0.5 |
| | Thermo Electron Corporation | 48 | Gas Filter Correlation Spectroscropy | 0.5 |

Note: New Thermo Electron Corporation CO monitor installed June 29, 1982.

instances, the data sets are at or below the minimum detectable limit of the instrument, which limits the analysis that can be applied to the data.

A. Sulfur Dioxide

1. Objectives

The objective of monitoring for sulfur dioxide is to establish the ambient air concentration prior to and during tract development. The existing sulfur dioxide levels and associated environmental effects can be used as a basis for assessing future environmental changes that may be related to any increase in the concentration of sulfur dioxide.

2. Methods

The methods followed for collection of sulfur dioxide data were described in RBOSC MDP Monitoring Report 5 (RBOSC 1980).

3. Results and Discussion

Table 2-3 provides mean, maximum, and minimum concentrations of air quality parameters monitored at Tract C-a during 1982. The table shows that the maximum hourly concentration of sulfur dioxide measured at Site 1 was 0.024 ppm, while the mean concentration was 0.003 ppm. Most of the sulfur dioxide concentrations monitored during the current year were at or below the threshold of detection for the instruments. The highest hourly sulfur dioxide concentration recorded during the current year, 0.024 ppm, occurred on May 10 at 0300 hours. The source of this relatively low maximum value could not be determined. The second highest hourly concentration was 0.013 ppm.

Comparison of the current year's data (Table 2-3) with data from earlier years (1981, Table 2-4; 1980, Table 2-5; February 1975-January 1977, Table 2-6) show that yearly maximum and average sulfur dioxide concentrations have been similar in each of the years. The maximum hourly

Table 2-3. Summary of Air Quality Data Collected from January to December 1982, Tract C-a

| Parameter | Units | Minimum[1] | Maximum[1] | Arithmetic Mean |
|---|---|---|---|---|
| | | Site 1 | | |
| $SO_2$ | ppm | 0.002 | 0.024 | 0.003 |
| $H_2S$ | ppm | 0.002 | 0.012 | 0.003 |
| NO | ppm | 0.005 | 0.014 | 0.005 |
| $NO_x$ | ppm | 0.005 | 0.011 | 0.005 |
| $O_3$ | ppm | 0.016 | 0.078 | 0.043 |
| CO | ppm | 0.5 | 1.0 | 0.5 |
| TSP[3] | $\mu g/m^3$ | 1 | 80 | 11[2] |
| | | Site 2 | | |
| TSP[3] | $\mu g/m^3$ | 1 | 65 | 10[2] |
| | | Site 3 | | |
| TSP[3] | $\mu g/m^3$ | 2 | 79 | 12[2] |

[1] Hourly average.

[2] Geometric Mean.

[3] 24-hour averages.

Table 2-4. Summary of Air Quality Data Collected from January to December 1981, Tract C-a

| Parameter | Units | Minimum[1] | Maximum[1] | Arithmetic Mean |
|---|---|---|---|---|
| | | Site 1 | | |
| $SO_2$ | ppm | 0.002 | 0.047 | 0.003 |
| $H_2S$ | ppm | 0.002 | 0.015 | 0.004 |
| NO | ppm | 0.005 | 0.061 | 0.005 |
| $NO_x$ | ppm | 0.005 | 0.039 | 0.005 |
| $O_3$ | ppm | 0.012 | 0.070 | 0.043 |
| CO | ppm | 0.5 | 1.0 | 0.5 |
| TSP[3] | $\mu g/m^3$ | 1 | 44 | 15[2] |
| | | Site 2 | | |
| TSP[3] | $\mu g/m^3$ | 1 | 54 | 15[2] |
| | | Site 3 | | |
| TSP[3] | $\mu g/m^3$ | 2 | 73 | 21[2] |

[1] Hourly average.

[2] Geometric Mean.

[3] 24-hour averages.

Table 2-5. Summary of Air Quality Data Collected from January to December 1980, Tract C-a

| Parameter | Units | Minimum[1/] | Maximum[1/] | Arithmetic Mean |
|---|---|---|---|---|
| | | Site 1 | | |
| $SO_2$ | ppm | 0.002 | 0.036 | 0.002 |
| $H_2S$ | ppm | 0.002 | 0.013 | 0.003 |
| NO | ppm | 0.005 | 0.061 | 0.005 |
| $NO_x$ | ppm | 0.005 | 0.062 | 0.005 |
| $O_3$ | ppm | 0.013 | 0.077 | 0.045 |
| CO | ppm | 0.5 | 0.9 | 0.5 |
| TSP[3/] | $\mu g/m^3$ | 2 | 61 | 13[2/] |
| | | Site 2 | | |
| TSP[3/] | $\mu g/m^3$ | 1 | 61 | 12[2/] |
| | | Site 3 | | |
| TSP[3/] | $\mu g/m^3$ | 1 | 96 | 18[2/] |

[1/] Hourly average.

[2/] Geometric Mean.

[3/] 24-hour averages.

Table 2-6. Summary of Air Quality Data Collected from February 1975 to January 1977 (Baseline Period), Tract C-a

| Parameter | Units | Minimum(2) | Maximum(2) | Arithmetic Mean |
|---|---|---|---|---|
| | | Site 1 | | |
| $SO_2$ | ppm | 0.000 | 0.09 | 0.01 |
| $H_2S$ | ppm | 0.000 | 0.05 | 0.01 |
| NO | ppm | 0.000 | 0.237 | 0.008 |
| $NO_x$ | ppm | 0.000 | 0.234 | 0.009 |
| $O_3$ | ppm | 0.000 | 0.068 | 0.034 |
| CO | ppm | 0.000 | 4.2 | 0.6 |
| TSP[3/] | $\mu g/m^3$ | 1 | 211 | 9[2/] |
| | | Site 2 | | |
| TSP[3/] | $\mu g/m^3$ | 1 | 102 | 9[2/] |
| | | Site 3 | | |
| TSP[3/] | $\mu g/m^3$ | 1 | 281 | 15[2/] |

1/ Hourly Average.

2/ Geometric Mean.

3/ 24-hour Average.

sulfur dioxide concentration in 1981 (0.047 ppm) was caused by emissions from Retort 1; in 1980, the maximum concentration (0.036 ppm) was caused by emissions from Retort 0; during the baseline period, the maximum concentration (0.09 ppm) was at least partially the result of less accurate and sophisticated instrumentation. The yearly means during both the baseline and MDP periods have been at or below the threshold of detection of the monitoring equipment.

## B. Hydrogen Sulfide

### 1. Objectives

The objective of monitoring hydrogen sulfide in the ambient air on the tract is to establish the background value. Tract development, which will involve recovery of sulfur-bearing organics, may release hydrogen sulfide into the ambient air. Future concentrations of this constituent may be compared to pre-development conditions to assess environmental impacts.

### 2. Methods

The methods for collection of hydrogen sulfide data were described in RBOSC MDP Monitoring Report 5 (RBOSC 1980).

### 3. Results and Discussion

Table 2-3 shows that maximum concentrations of hydrogen sulfide during 1982 was 0.012 ppm at Site 1. Annual mean concentration was 0.003 ppm. Comparisons with previous data show that the maximum concentrations have been low, while the mean annual concentrations have remained at or below the threshold of detection.

C. Oxides of Nitrogen

1. Objectives

Oxides of nitrogen are monitored to establish the existing natural background levels prior to major tract development and operation. Tract operations will involve substantial combustion during the retorting process with the resultant generation of oxides of nitrogen. Nitric oxide in the presence of sunlight and hydrocarbons may be a mechanism for smog production.

2. Methods

The methods followed for collection of oxides of nitrogen data were described in MDP Monitoring Report 2 (RBOSC 1978a).

3. Results and Discussion

The concentrations of both nitric oxide and oxides of nitrogen were below the threshold of detection most of the time during the current year, resulting in a mean annual concentration of both these variables at or below 0.005 ppm. These values are similar to those obtained during previous years--no annual mean for either nitric oxide or oxides of nitrogen exceeded 0.01 ppm. The maximum concentrations measured during 1982 were 0.014 ppm for nitric oxide and 0.011 ppm for oxides of nitrogen.

D. Carbon Monoxide

Carbon monoxide is produced by incomplete oxidation of carbon during combustion. Vehicular use and fuel combustion during tract development may result in the emission of carbon monoxide in the tract area.

1. Objectives

Carbon monoxide is monitored to establish the ambient air concentration of this constituent prior to and during tract development activities.

2. Methods

The methods followed for collection of carbon monoxide data were described in MDP Monitoring Report 2 (RBOSC 1978a). The carbon monoxide monitor was replaced at Site 1 on June 29 (Table 2-2). The improved reliability and stability of the new instrument has resulted in better data recovery.

3. Results and Discussion

The measured concentration of carbon monoxide at Site 1 was at or below the threshold of detection most of the time. Maximum concentration was 1.0 ppm, and mean concentration was 0.5 ppm. These results are very similar to those of previous years.

E. Ozone

1. Objectives

Ozone monitoring is conducted to determine the ambient air concentration of this constituent prior to and during tract development and operation. The potential emissions of oxides of nitrogen coupled with hydrocarbons in strong sunlight can produce photochemical reactions leading to the formation of ozone.

2. Methods

The methods followed for collection of ozone data were described in RBOSC MDP Monitoring Report 2 (RBOSC 1978a).

3. Results and Discussion

The range of ozone concentrations recorded during 1982 at Site 1, as shown in Table 2-3, was 0.016 to 0.078 ppm. The mean concentration of ozone was 0.043 ppm. Thus, there were no violations of the primary or secondary National Ambient Air Quality Standard (NAAQS) for ozone (0.12 ppm) at either site. These concentrations are comparable to those found during the previous monitoring periods (Tables 2-4 through 2-6).

Figures 2-1 through 2-5 are histograms of the hourly ozone concentrations at Site 1 during each of the four seasons and for the entire year. The frequency of ozone concentrations is shown for 0.01 ppm increments. The midpoints of the concentration are shown for these increments (e.g., a midpoint of 0.025 ppm is shown for the range of 0.020 to 0.029 ppm). Site 1 shows a fairly narrow distribution of concentration during each season, with a shift to higher concentrations during the spring and summer. This ozone peak during the summer is a common phenomenon (U.S. EPA 1978).

Previous year-end reports discussed the common phenomenon of relatively high concentrations of ozone occurring at remote sites such as Tract C-a. The conclusion, based on analysis of the site data and research done at other rural sites, was that these relatively high concentrations may be due to a number of factors, including stratospheric injection, photochemical reactions, or long-range transport. The concept of local production of ozone as an important factor has not been supported by the observed events.

F. Particulates

1. Objectives

The objectives of total suspended particulate (TSP) monitoring are to establish a natural background TSP concentration and to monitor the effects of tract development on TSP concentrations.

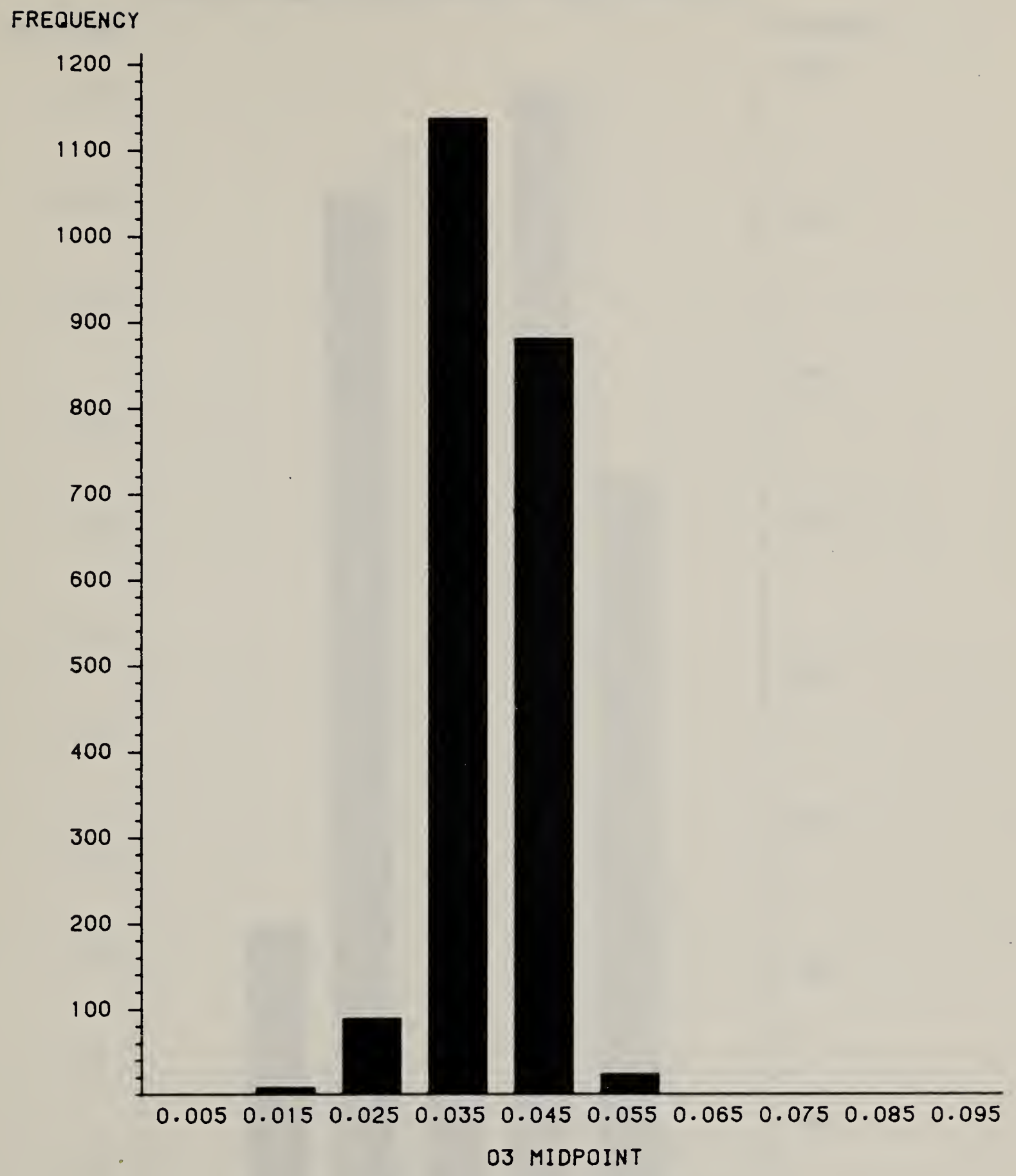



FIGURE 2-1. HISTOGRAM OF HOURLY OZONE CONCENTRATIONS (PPM) AT SITE 1, TRACT C-A

FIGURE 2-2. HISTOGRAM OF HOURLY OZONE CONCENTRATIONS (PPM) AT SITE 1, TRACT C-A

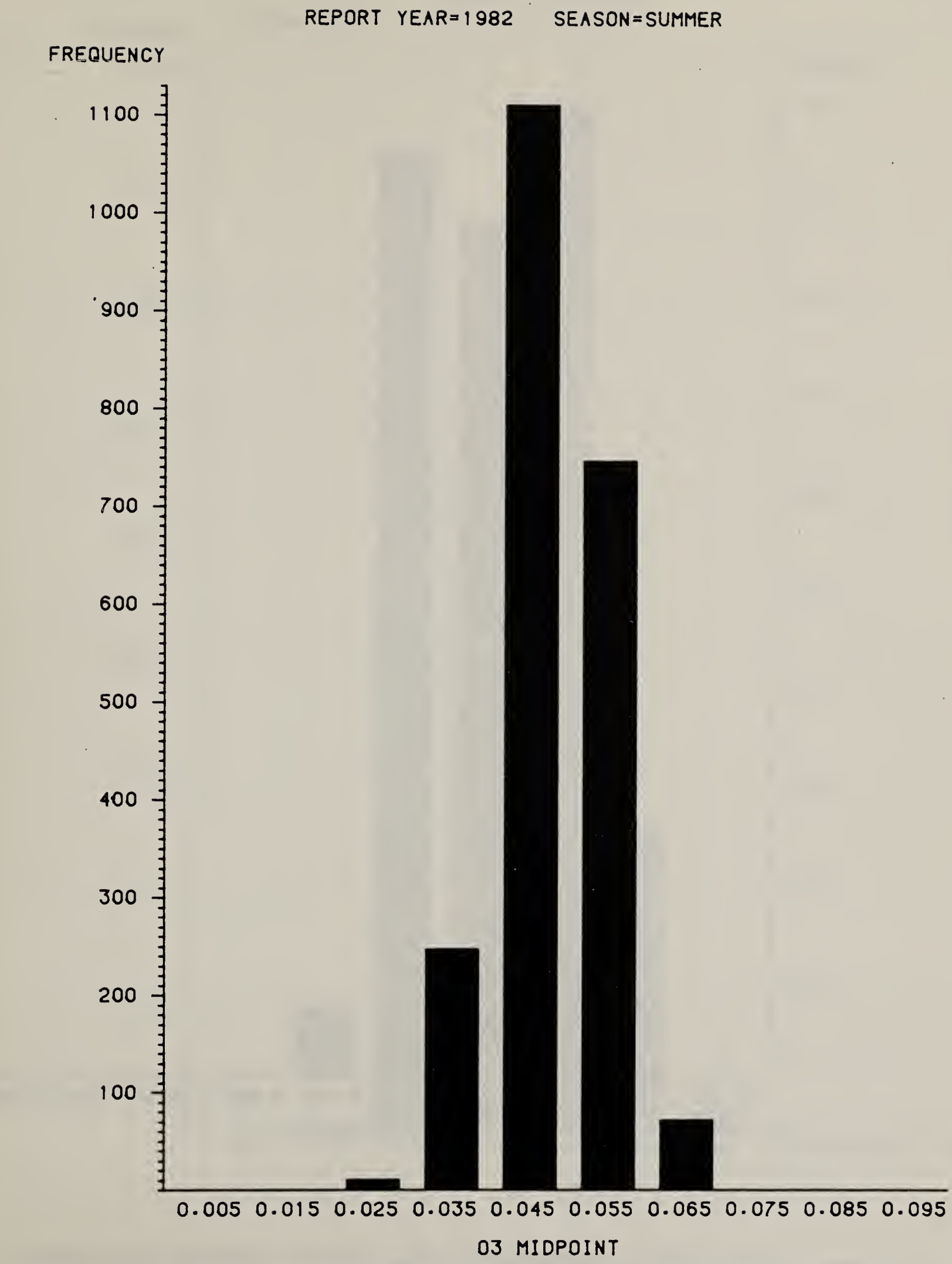



FIGURE 2-3. HISTOGRAM OF HOURLY OZONE CONCENTRATIONS (PPM) AT SITE 1, TRACT C-A

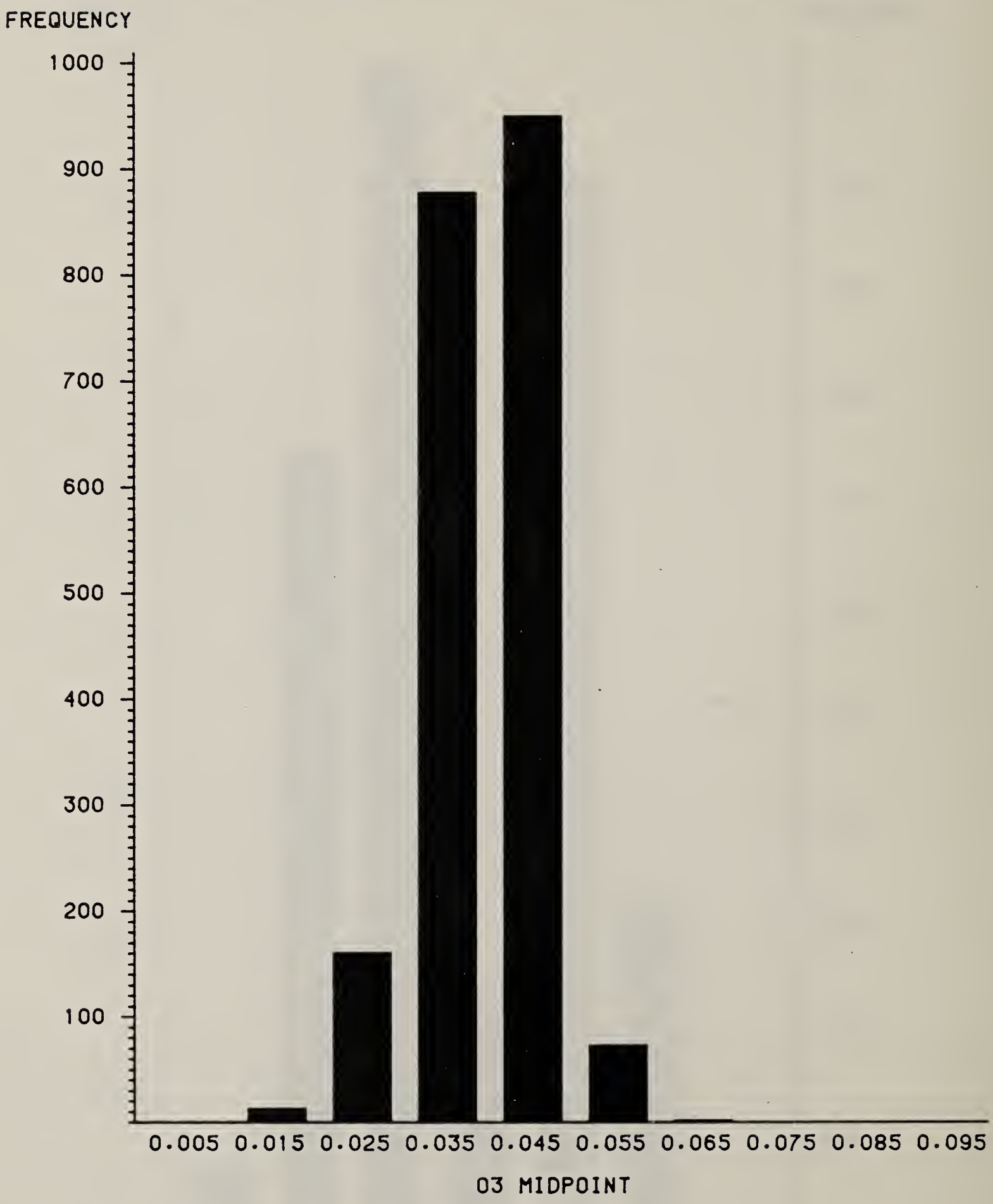



FIGURE 2-4. HISTOGRAM OF HOURLY OZONE CONCENTRATIONS (PPM) AT SITE 1, TRACT C-A

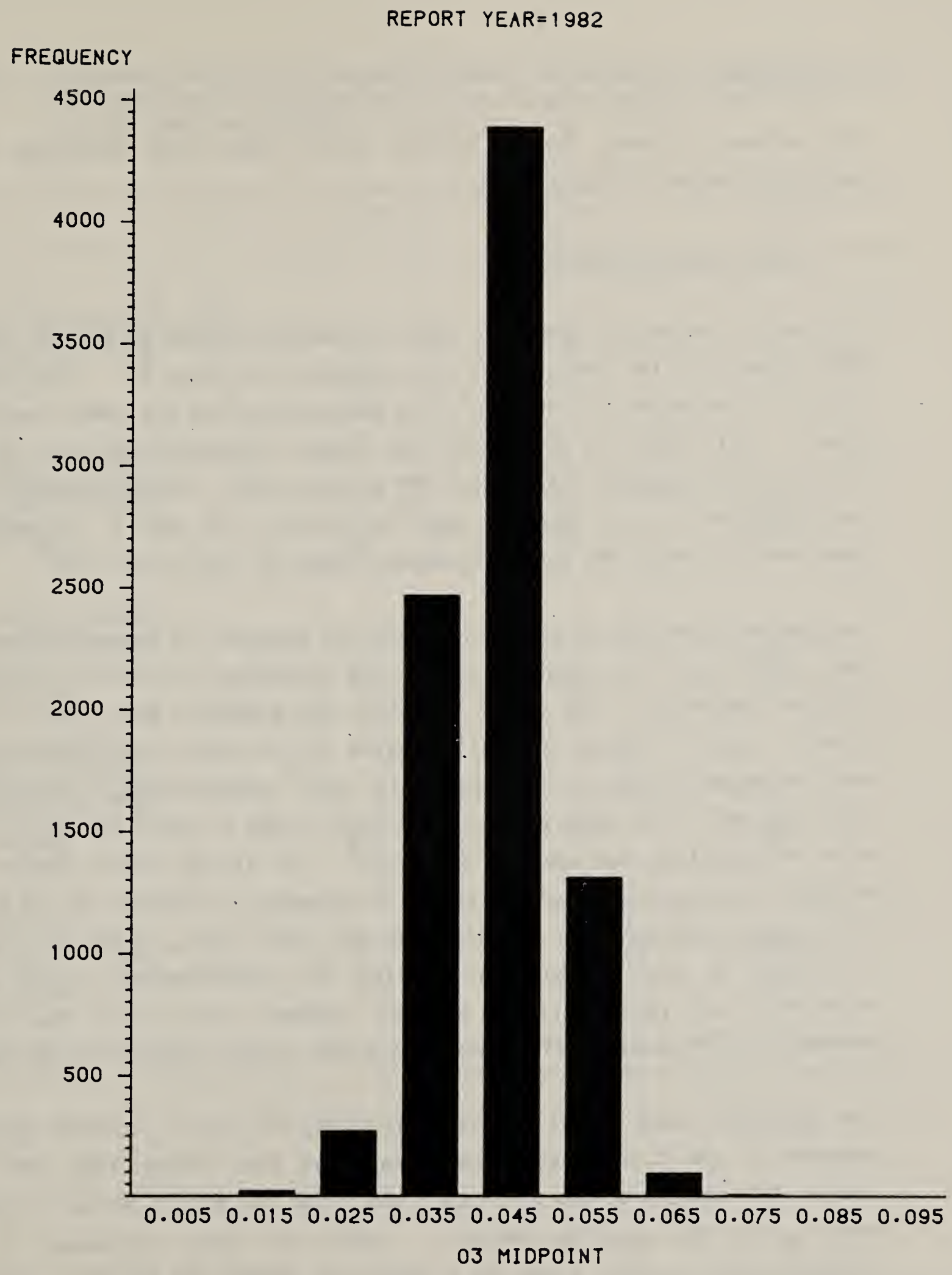



FIGURE 2-5. HISTOGRAM OF HOURLY OZONE CONCENTRATIONS (PPM) AT SITE 1, TRACT C–A

## 2. Methods

The methods followed for collection of TSP data were described in MDP Monitoring Report 4 (RBOSC 1979a).

## 3. Results and Discussion

Quarterly and annual geometric mean and maximum values of the TSP data for 1982 at each of the three sites are presented in Table 2-7. The highest 24-hour concentration, 80 $\mu g/m^3$, was measured during the summer quarter at Site 1. This value is well below the 24-hour secondary National Ambient Air Quality Standard (NAAQS) for TSP of 150 $\mu g/m^3$. Annual geometric means for 1982 were 11, 10, and 12 $\mu g/m^3$ at Sites 1, 2, and 3, respectively. These are for below the annual secondary NAAQS for TSP of 60 $\mu g/m^3$.

The quarterly and annual geometric means and maximum TSP concentrations for 1981, 1980, and the baseline period are presented in Tables 2-8 through 2-10 for comparison. The tables show that the geometric mean annual TSP at Sites 1 and 2, located generally upwind of the tract development areas, have decreased slightly from the 12-15 $\mu g/m^3$ concentrations occurring in 1980 and 1981. The 1982 concentrations of 10 and 11 $\mu g/m^3$ are more in line with the baseline averages of 8-9 $\mu g/m^3$. It is not clear whether this decrease from previous years is due to a decrease in activity at the tract, the general decrease in activity in the area (e.g., less oil and gas drilling), or other factors influencing TSP concentrations, such as a relatively wet year. It is evident, however, that this year-to-year decrease in TSP concentrations was consistent in each quarter of the year.

The geometric mean annual TSP concentrations at Site 3, located generally downwind of the tract development area, have been higher than the mean annual TSP concentrations at Sites 1 and 2 for the entire period of record, even during the baseline period. Some of the increase in TSP concentrations at Site 3 may be a result of traffic on several roads that are located in the vicinity of the site. During 1982, the mean TSP concentration at Site 3 was only 1 or 2 $\mu g/m^3$ higher than Sites 1 and 2,

Table 2-7. Quarterly and Annual Geometric Means and Maximum Values of 24-hour Average Total Suspended Particulate Concentrations from ($\mu g/m^3$) during 1982 on Tract C-a

| | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| Winter 1982 (Jan, Feb, Dec) | | | |
| Geometric Mean | 6 | 5 | 5 |
| Maximum | 17 | 15 | 18 |
| Spring 1982 (Mar-May) | | | |
| Geometric Mean | 13 | 12 | 17 |
| Maximum | 48 | 48 | 52 |
| Summer 1982 (Jun-Aug) | | | |
| Geometric Mean | 22 | 20 | 28 |
| Maximum | 80 | 65 | 79 |
| Fall 1982 (Sep-Nov) | | | |
| Geometric Mean | 9 | 9 | 8 |
| Maximum | 20 | 24 | 32 |
| 1982 Annual | | | |
| Geometric Mean | 11 | 10 | 12 |
| Maximum | 80 | 65 | 79 |

Table 2-8. Quarterly and Annual Geometric Means and Maximum Values of 24-hour Average Total Suspended Particulate Concentrations from January to December 1981 ($\mu g/m^3$) on Tract C-a

| | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| Winter 1981 (Jan, Feb, Dec) | | | |
| Geometric Mean | 9 | 9 | 15 |
| Maximum | 25 | 25 | 48 |
| Spring 1981 (Mar-May) | | | |
| Geometric Mean | 16 | 15 | 21 |
| Maximum | 41 | 44 | 42 |
| Summer 1981 (Jun-Aug) | | | |
| Geometric Mean | 25 | 26 | 38 |
| Maximum | 44 | 49 | 73 |
| Fall 1981 (Sep-Nov) | | | |
| Geometric Mean | 14 | 13 | 17 |
| Maximum | 39 | 54 | 54 |
| 1981 Annual | | | |
| Geometric Mean | 15 | 15 | 21 |
| Maximum | 44 | 54 | 73 |

Table 2-9. Quarterly and Annual Geometric Means and Maximum Values of 24-hour Average Total Suspended Particulate Concentrations from January to December 1980 ($\mu g/m^3$) on Tract C-a

| | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| Winter 1980 (Jan, Feb, Dec) | | | |
| Geometric Mean | 7 | 6 | 9 |
| Maximum | 17 | 20 | 36 |
| Spring 1980 (Mar-May) | | | |
| Geometric Mean | 11 | 12 | 14 |
| Maximum | 36 | 42 | 51 |
| Summer 1980 (Jun-Aug) | | | |
| Geometric Mean | 29 | 21 | 43 |
| Maximum | 61 | 51 | 96 |
| Fall 1980 (Sep-Nov) | | | |
| Geometric Mean | 16 | 15 | 26 |
| Maximum | 56 | 61 | 76 |
| 1980 Annual | | | |
| Geometric Mean | 14 | 12 | 19 |
| Maximum | 61 | 61 | 96 |

Table 2-10. Quarterly and Annual Geometric Means and Maximum Values of 24-Hour Average Total Suspended Particulate Concentrations for the Baseline Period (February 1975 to January 1977) ($\mu g/m^3$) on Tract C-a

| | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| February 1975 | | | |
| Geometric Mean | -- | 3 | 5 |
| Maximum | -- | 10 | 12 |
| Spring 1975 (Mar-May) | | | |
| Geometric Mean | 29 | 11 | 23 |
| Maximum | 95 | 84 | 163 |
| Summer 1975 (Jun-Aug) | | | |
| Geometric Mean | 22 | 15 | 47 |
| Maximum | 211 | 95 | 247 |
| Fall 1975 (Sep-Nov) | | | |
| Geometric Mean | 6 | 16 | 18 |
| Maximum | 52 | 102 | 137 |
| Winter 1975-76 (Dec-Feb) | | | |
| Geometric Mean | 2 | 2 | 4 |
| Maximum | 10 | 11 | 14 |
| Spring 1976 (Mar-May) | | | |
| Geometric Mean | 11 | 11 | 11 |
| Maximum | 80 | 51 | 130 |
| Summer 1976 (Jun-Aug) | | | |
| Geometric Mean | 22 | 22 | 27 |
| Maximum | 81 | 57 | 105 |
| Fall 1976 (Sep-Nov) | | | |
| Geometric Mean | 12 | 15 | 35 |
| Maximum | 53 | 46 | 281 |
| Winter 1976-77 (Dec-Jan) | | | |
| Geometric Mean | 5 | 6 | 5 |
| Maximum | 18 | 57 | 59 |
| 1975-76 Annual | | | |
| Geometric Mean | 9 | 9 | 18 |
| Maximum | 211 | 102 | 247 |
| 1976-77 Annual | | | |
| Geometric Mean | 8 | 9 | 12 |
| Maximum | 81 | 57 | 281 |

compared to previous years when the increase ranged from 3 to 13 $\mu g/m^3$. This change probably reflects the lowest level of activity on and around the tract since the baseline period.

The annual cumulative frequency distributions of the TSP concentrations at each of the three sites are presented in Figure 2-6. The distributions for Sites 1 and 2 are similar, with the distribution for Site 3 slightly higher. The figure shows that the 50 percent probability points for the TSP concentrations in 1982 are 11 $\mu g/m^3$ for Site 1, 12 $\mu g/m^3$ for Site 2, and 13 $\mu g/m^3$ for Site 3. These are considerably lower than the values obtained in 1981 of 17 $\mu g/m^3$, 16 $\mu g/m^3$, and 24 $\mu g/m^3$ for the same sites, respectively. The 50 percent probability concentrations obtained for the baseline period, 10 $\mu g/m^3$ for Site 1, 12 $\mu g/m^3$ for Site 2, and 22 $\mu g/m^3$ for Site 3, agree well with the current year's data, with the exception of Site 3 which was lower in 1982.

## Correlation Analysis

Table 2-11 provides the correlation coefficient (r) and the coefficient of determination ($r^2$) between sites for the TSP concentrations. The correlations were computed on an annual data set for each of the two baseline years and the four developmental years starting in 1979. The correlations between the sites were lowest for the baseline years, and have improved more or less steadily since. For instance, the correlation between Sites 1 and 2 averaged 0.58 during the baseline, 0.87 during the period of maximum activity of the MDP program, and 0.96 during 1982, when activity on and around the tract decreased considerably. The improvement in correlations between sites might be expected from the period of the very active MDP program to the present, but no rationale for the relatively low correlations during the baseline years can be developed.

The correlations for the current year are quite high, since the coefficient of determination given in Table 2-11 for Sites 1 and 2 ($r^2_{12}$) shows that 91 percent of the annual variation in TSP concentration at Site 1 is associated with the variations at Site 2. Similarly, an $r^2_{13}$ of 0.81

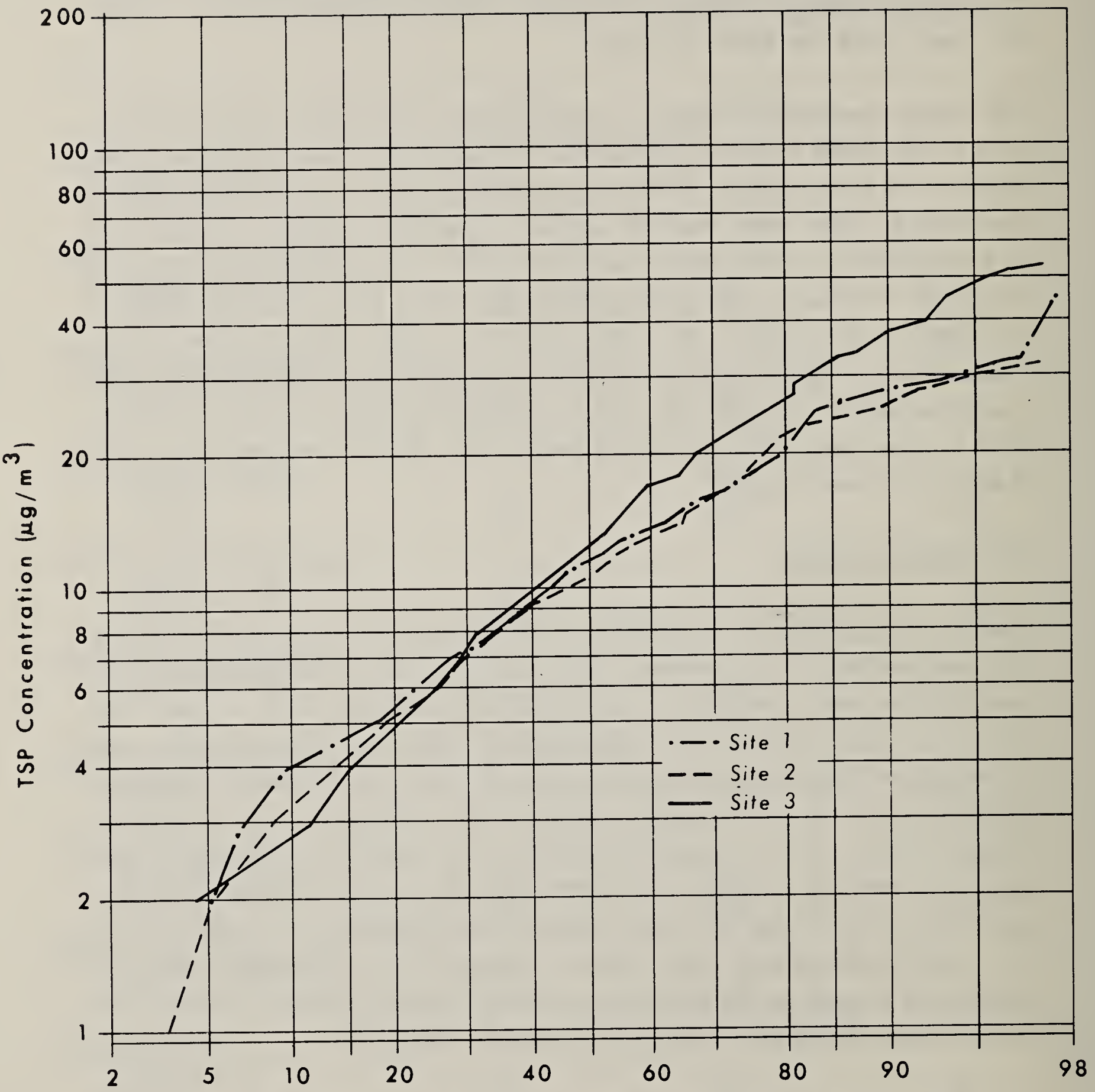



Figure 2-6. Cumulative Frequency Distributions of Total Suspended Particulate (TSP) from the Three Tract C-a Monitoring Sites, January-December, 1982

Table 2-11. Correlation Coefficients (r) and Coefficients of Determination ($r^2$), for the 24-hour Average Total Suspended Particulate Concentrations at Sites 1, 2 , and 3, Tract C-a.

| | Baseline | | | | Modular Development Phase | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (2/75-1/76) | | (2-76-1/77) | | (1979) | | (1980) | | (1981) | | (1982) | |
| Correlation | r | $r^2$ | r | $r^2$ | r | $r^2$ | r | $r^2$ | r | $r^2$ | r | $r^2$ |
| Sites 1 vs 2 | 0.53 | 0.28 | 0.63 | 0.40 | 0.57 | 0.33 | 0.86 | 0.74 | 0.88 | 0.77 | 0.96 | 0.91 |
| Sites 1 vs 3 | 0.31 | 0.10 | 0.49 | 0.24 | 0.60 | 0.36 | 0.83 | 0.69 | 0.85 | 0.72 | 0.90 | 0.81 |
| Sites 2 vs 3 | 0.56 | 0.32 | 0.47 | 0.22 | 0.71 | 0.50 | 0.76 | 0.58 | 0.77 | 0.60 | 0.91 | 0.82 |

The sample numbers for these correlations range from 72 to 115.

indicates that the annual variation in TSP concentration at Site 1 is closely associated with the variation at Site 3. This is borne out by inspection of the data, which showed that the highest 24-hr TSP concentrations in 1982 occurred simultaneously at all three sites. This day, in early June, had meteorological conditions that were nearly ideal for producing high TSP concentrations at a remote site: high winds (average of 15 mph with gusts to 40 mph) and no precipitation over the previous six days. The similarity in the patterns of TSP concentrations appear to primarily reflect regional rather than localized influences. With the low present activity levels in the area, the localized influences on TSP concentrations are probably minimal.

The results of a different type of correlation are shown in Table 2-12: whereas Table 2-11 presents the correlations between sites within one year (1982), Table 2-12 presents the correlations between 1982 and previous years for each site. The correlations within one year are much higher, with an average $r^2$ of 0.85 during 1982, than between years, with an average $r^2$ of less than 0.20. The correlations are much higher between sites for any given year than at one site between years. It is to be expected that the correlation between years would be somewhat lower, since specific meteorological or site activity variables are different between years (e.g., precipitation events, occurrence of high winds, etc.) However, the same general trend of hot, dusty conditions in the summer and snowcover in the winter would intuitively lead to the conclusion that the correlations might be higher than presented in Table 2-12. Apparently, the variability of specific events between years is rather high.

Table 2-12. Annual Correlation Coefficients (r), and Coefficients of Determination ($r^2$) Between Years for the 24-Hr Total Suspended Particulate Concentration at Sites 1, 2, and 3, Tract C-a

| | Site 1 | | Site 2 | | Site 3 | |
|---|---|---|---|---|---|---|
| | r | $r^2$ | r | $r^2$ | r | $r^2$ |
| 1979 vs. 1982 | 0.06 | 0.00 | 0.23 | 0.05 | 0.22 | 0.05 |
| 1980 vs. 1982 | 0.46 | 0.22 | 0.38 | 0.14 | 0.37 | 0.14 |
| 1981 vs. 1982 | 0.41 | 0.17 | 0.40 | 0.16 | 0.41 | 0.17 |

## 2.2 METEOROLOGY

Meteorological parameters are monitored to provide information on the general climate of Tract C-a and vicinity. They will also provide a basis for estimating the potential impact of emissions that may result from tract development and operation. Two meteorological monitoring sites were in operation during 1982. Meteorological data were taken at the 10-m level at both sites, and also at the 60-m level at Site 1, the main sampling site. The parameters measured at each site are given in Table 2-1. Site 1 is at an elevation of 7,335 feet above mean sea level (MSL) just west of the tract boundary. Site 2 is at an elevation of 7,360 feet MSL to the southwest of the tract. This section of the report deals primarily with the meteorological data collected from both sites during the period January-December 1982. Precipitation data and snow depth measurements are presented in Appendices 2-2.3 and 2-2.4, respectively. Barometric pressure data are presented in Appendix 2-2.5. The data for the baseline period and the first year of the MDP period were extracted from earlier reports (RBOSP 1977, RBOSC MDP Monitoring Report 3, RBOSC MDP Monitoring Report 5, RBOSC MDP Monitoring Report 7, and RBOSC MDP Monitoring Report 9) for comparison purposes. Plots of meteorological data collected from continuous monitoring instruments are presented in Appendices 2-2.1 and 2-2.2.

### A. Temperature and Stability

#### 1. Objectives

Ambient air temperature, a primary climatic parameter, provides basic information on monthly and year-to-year variability of climatic conditions at the C-a tract. The measured vertical temperature differential within the lowest boundary layers is a measure of the stability of the atmosphere. Atmospheric stability strongly influences the dispersion of emissions into the atmosphere, and is therefore an important input into air quality models.

## 2. Methods

The methods followed for collection of temperature data were described in MDP Monitoring Report 3 (RBOSC 1979).

## 3. Results and Discussions

Table 2-13 presents a summary of monthly, seasonal, and annual temperature statistics for the current year at each of the two monitoring sites on the tract (10-m level). The temperature statistics presented for each site include means, average daily maxima, average daily minima, absolute maxima, and absolute minima.

The monthly mean temperatures for the two sites are similar, with Site 2 slightly warmer than Site 1. The mean annual temperatures were 6.2 C at Site 1 and 7.3 C at Site 2. Absolute maximum temperatures and absolute minimum temperatures at Site 1 and Site 2 were also very similar. The extreme temperatures recorded at the tract during the current year were 31.9 C and -27.9 C, both at Site 2.

The temperature record allows the calculation of the length of the frost-free period at each site. This information is helpful in determining the required hardiness and suitability of plants that will be used in revegetation of the tract. However, it should be noted that these temperatures are measured at 10-m above ground level, so that the first and last excursion below 0 C at 10-m (as used here) probably represents a "hard frost" at the ground surface.

Table 2-14 presents the frost-free period for the seven years at the two sites. The table also provides the 1980, 1981, and 1982 frost-free period for several climatological stations located in the vicinity of the tract. It should be noted that the National Weather Service stations measure the temperature at 2 meters, so the data are not strictly comparable to the data taken at the tract. However, they are included for reference.

Table 2-13. Monthly, Seasonal, and Annual Summary of Temperatures (C) (Mean, Average Daily Maximum, Average Daily Minimum, Absolute Maximum, Absolute Minimum), January-December 1982, 10-m Level of Site 1 and Site 2, Tract C-a.

| | Site 1 | | | | | Site 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Period | Mean | Avg Daily Max | Avg Daily Min | Abs Max | Abs Min | Mean | Avg Daily Max | Avg Daily Min | Abs Max | Abs Min |
| January | -4.4 | -1.0 | -7.8 | 7.8 | -19.0 | -4.3 | -0.8 | -8.2 | 7.6 | -20.0 |
| February | -3.4 | 0.0 | -7.1 | 11.1 | -26.2 | -3.9 | 0.2 | -7.7 | 11.3 | -27.9 |
| March | 0.6 | 4.0 | -2.8 | 9.2 | -8.0 | 0.6 | 4.2 | -2.8 | 9.3 | -8.6 |
| April | 3.6 | 8.0 | -1.7 | 16.6 | -11.0 | 3.9 | 8.4 | -1.6 | 16.6 | -10.9 |
| May | 9.3 | 13.4 | 5.1 | 21.1 | -0.9 | 9.5 | 13.7 | 5.0 | 21.5 | -0.8 |
| June | 15.3 | 20.0 | 10.0 | 27.8 | 1.9 | 16.0 | 20.8 | 10.5 | 28.6 | 2.1 |
| July | 19.6 | 24.0 | 15.0 | 29.4 | 5.0 | 21.0 | 25.8 | 16.2 | 31.9 | 5.9 |
| August | 19.4 | 23.7 | 15.3 | 27.9 | 10.2 | 21.8 | 26.2 | 17.2 | 30.2 | 12.9 |
| September | 14.2 | 17.5 | 10.2 | 26.3 | 1.8 | 16.1 | 20.4 | 12.0 | 29.1 | 4.2 |
| October | 5.3 | 9.2 | 1.2 | 16.3 | -7.0 | 7.8 | 12.1 | 3.5 | 20.5 | -5.4 |
| November | -0.7 | 2.6 | -3.7 | 9.5 | -12.0 | 1.4 | 4.8 | -1.6 | 10.5 | -10.7 |
| December | -4.5 | -1.7 | -7.3 | 6.0 | -18.0 | -2.2 | 0.9 | -5.2 | 8.0 | -15.4 |
| Seasonal | | | | | | | | | | |
| Winter (Dec, Jan, Feb) | -4.1 | -0.9 | -7.4 | 11.1 | -26.2 | -3.5 | 0.1 | -7.0 | 11.3 | -27.9 |
| Spring (Mar, Apr, May) | 4.5 | 8.5 | 0.2 | 21.1 | -11.0 | 4.7 | 8.8 | 0.2 | 21.5 | -10.9 |
| Summer (Jun, July, Aug) | 18.1 | 22.6 | 13.4 | 29.4 | 1.9 | 19.6 | 24.3 | 14.6 | 31.9 | 2.1 |
| Fall (Sept, Oct, Nov) | 6.3 | 9.8 | 2.6 | 26.3 | -12.0 | 8.4 | 12.4 | 4.6 | 29.1 | -10.7 |
| Annual | 6.2 | 10.0 | 2.2 | 29.4 | -26.2 | 7.3 | 11.4 | 3.1 | 31.9 | -27.9 |

Table 2-14. Frost-free Period for Sites 1 and 2 during the last Four Years, and the 1981 Frost-free Period for Climatological Stations.

| | Frost-Free Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site 1 | | Site 2 | | Meeker | | Rangely | | Grand Junction | |
| Year | Length (Days) | Dates | Length (Days) | Dates | Length (Days) | Dates | Length (Days) | Dates | Length (Days) | Dates |
| 1982 | 147 | 05/11-10/05 | 155 | 05/06-10/08 | 114 | 06/09-10/01 | NA | NA | 173 | 04/21-10/11 |
| 1981 | 156 | 05/13-10/16 | 154 | 05/13-10/14 | 118 | 06/16-10/12 | NA | NA | 202 | 04/06-10/25 |
| 1980 | 144 | 05/25-10/16 | NA | NA | 101 | 06/02-09/11 | 123 | 06/02-10/03 | 192 | 04/14-10/23 |
| 1979 | 133 | 06/09-10/20 | 133 | 06/09-10/20 | | | | | | |
| 1978 | 111 | 05/31-09/19 | 111 | 05/31-09/19 | | | | | | |
| 1976 | 112 | 06/14-10/04 | 112 | 06/14-10/04 | | | | | | |
| 1975 | 132 | 05/29-10/08 | 132 | 05/29-10/08 | | | | | | |

The table shows that the frost-free period at Sites 1 and 2 has ranged from 111 to 156 days over the seven years of record. The last frost date in the spring at the tract is quite late, averaging around the first of June. The first frost date in the fall ranges from mid-September to mid-October.

The frost-free periods at Meeker and Rangely are somewhat shorter than on the tract (probably due to the difference in height above ground level that measurements are taken), but at Grand Junction the period is significantly longer. This is due at least partially to the lower elevation (4800 ft. at Grand Junction vs. 7,300 ft. at the tract sites).

Table 2-15 provides a summary of annual absolute minimum, absolute maximum, and mean values of the air temperature recorded at the three sites during each of the seven years of data collected to date, as well as the seven data years combined. There appears to have been no consistent trend during the period of record.

Stability classifications (A-F), based upon temperature differences ($\Delta T$) within a short vertical distance of the surface, are based on those in the Nuclear Regulatory Commission (NRC) Regulatory Guide 1.2 (NRC 1972). Other stability classification systems are based upon wind direction fluctuations, and will be presented in section 2.2(C). The most turbulent and unstable conditions are characterized by "A" stability, and the least turbulent and most stable conditions are characterized by "F" stability.

Table 2-16 presents the frequency distribution of stability classes by month and season for Site 1, based on data from 1982. Unstable (classes A, B, and C) conditions occurred predominantly during the summer. The occurrence of stable conditions showed less seasonal dependence.

Table 2-15. Summary of Annual and Combined Seven-Year Onsite Climatology of Absolute Minimum, Absolute Maximum and Mean Values of Temperture (C) During the Baseline and MDP Periods, Tract C-a.

| Temperatures[1/] | 2/75-1/76 | 2/76-1/77 | 1978 | 1979 | 1980 | 1981 | 1982 | Combined 7-Year Data Set |
|---|---|---|---|---|---|---|---|---|
| Site 1 (10-m level) | | | | | | | | |
| Absolute Minimum | -21.1 | -21.7 | -24.0 | -24.6 | -15.5 | -19.9 | -26.2 | -26.2 |
| Absolute Maximum | -30.1 | 29.7 | 30.4 | 28.5 | 28.0 | 29.7 | 29.4 | 30.4 |
| Mean | 6.1 | 7.2 | 7.1 | 6.6 | 7.6 | 8.0 | 6.2 | 7.0 |
| Site 2 (10-m level) | | | | | | | | |
| Absolute Minimum | -21.4 | -22.2 | -24.1 | -26.3 | -15.8 | -14.0 | -27.9 | -27.9 |
| Absolute Maximum | 27.5 | 29.4 | 30.5 | 28.9 | 30.0 | 31.2 | 31.9 | 31.9 |
| Mean | 5.5 | 6.9 | 7.4 | 7.0 | NA | 8.2 | 7.3 | 7.0 |

1/ Minimum and maximum annual temperatures are based on hourly average values for each 1-year period.

Table 2-16. Monthly, Seasonal, and Annual Occurrence (hours) of ΔT Stability Classes, January - December 1982, Site 1, Tract C-a

| Period | Stability Index A | B | C | D | E | F | Total |
|---|---|---|---|---|---|---|---|
| January | 0 | 0 | 2 | 351 | 338 | 53 | 744 |
| February | 0 | 5 | 18 | 268 | 356 | 23 | 670 |
| March | 16 | 40 | 59 | 315 | 307 | 7 | 744 |
| April | 120 | 51 | 48 | 183 | 267 | 27 | 696 |
| May | 84 | 50 | 52 | 208 | 310 | 39 | 743 |
| June | 103 | 51 | 58 | 165 | 242 | 101 | 720 |
| July | 115 | 51 | 57 | 142 | 288 | 91 | 744 |
| August | 56 | 46 | 71 | 165 | 304 | 102 | 744 |
| September | 25 | 17 | 26 | 58 | 112 | 32 | 270 |
| October | 31 | 47 | 64 | 196 | 328 | 52 | 718 |
| November | 9 | 14 | 35 | 254 | 355 | 28 | 695 |
| December | 3 | 6 | 11 | 316 | 358 | 50 | 744 |
| Winter | 3 | 11 | 31 | 935 | 1052 | 126 | 2158 |
| Spring | 220 | 141 | 159 | 706 | 884 | 73 | 2183 |
| Summer | 274 | 148 | 186 | 472 | 834 | 294 | 2208 |
| Fall | 65 | 78 | 125 | 508 | 795 | 112 | 1683 |
| Annual | 562 | 378 | 501 | 2621 | 3565 | 605 | 8232 |

## B. Dew Point

### 1. Objectives

Dew point data, collected since late July 1978, are used to evaluate potential cooling system alternatives. The data are more directly useable than relative humidity data, which were collected onsite for the same purposes during the baseline period and from December 1977 to late July 1978. Relative humidity can be determined from concurrent dew point and temperature measurements.

### 2. Methods

The methods followed for collection of dew point data were described in MDP Monitoring Report 4 (RBOSC 1979a). A new dew point monitor was installed in December 1981 to alleviate chronic maintenance problems with an earlier instrument. However, a direct lightning strike on September 12 destroyed the sensor. No additional data could be collected until late December.

### 3. Results and Discussion

Table 2-17 presents a summary of monthly, seasonal, and annual dew point statistics for the current year for the data collected at Site 1, although some seasonal and annual values are not valid because of the three-month data loss. The mean monthly dew point ranged from -10.9 C in April to -1.9 C in August. The maximum dew point, 12.0 C, occurred in August, and the minimum, -23.6 C, occurred in January.

## C. Wind Speed and Wind Direction

### 1. Objectives

The wind speed and wind direction influence atmospheric dispersion. Measurement of the frequency of occurrence of wind speed and wind direction classes can also be used in interpreting air quality data.

Table 2-17. Maximum, Minimum, and Mean Dew Point (C) at Site 1, January-December 1982, RBOSC Tract C-a

| Month | Maximum Dew Point | Minimum Dew Point | Mean Dew Point |
|---|---|---|---|
| January | -3.5 | -23.6 | -10.8 |
| February | 1.6 | -20.3 | -8.2 |
| March | 1.8 | -15.8 | -7.3 |
| April | -0.8 | -19.9 | -10.9 |
| May | NA | NA | NA |
| June | -1.0 | -13.3 | -6.7 |
| July | 3.7 | -18.7 | -6.2 |
| August | 12.0 | -11.5 | -1.9 |
| September | NA | NA | NA |
| October | NA | NA | NA |
| November | NA | NA | NA |
| December | NA | NA | NA |
| Season | | | |
| Winter[1/] | 1.6 | -23.6 | -9.5 |
| Spring[1/] | 1.8 | -19.9 | -9.1 |
| Summer | 12.0 | -18.7 | -4.9 |
| Fall | NA | NA | NA |
| Annual | 12.0 | -23.6 | NA |

1/ Based on two months of data.

## 2. Methods

The methods followed for collection of wind data were described in MDP Monitoring Report 3 (RBOSC 1979).

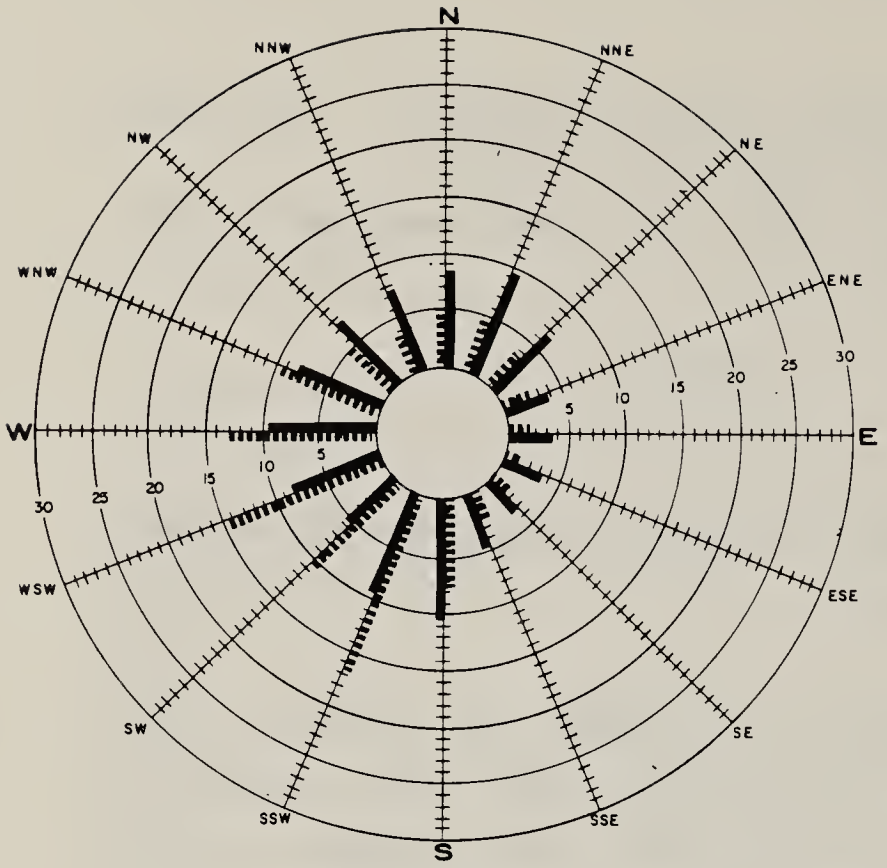
## 3. Results and Discussion

Seasonal and annual wind roses for each of the three sites for the current year are presented in Figures 2-7 to 2-12.

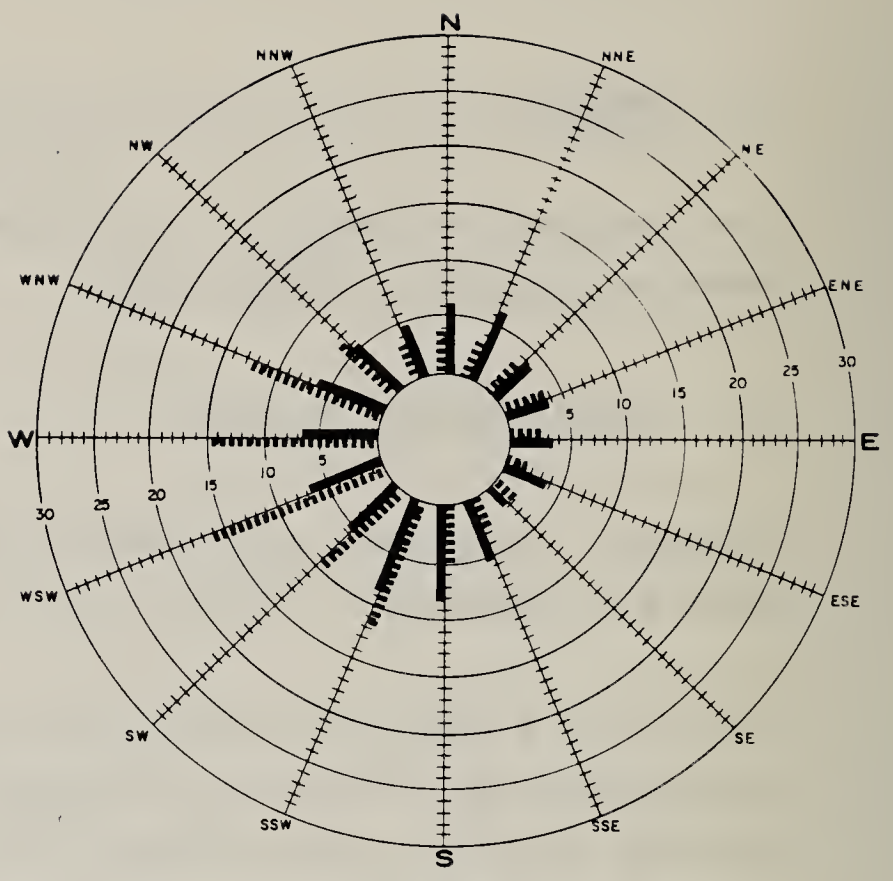
The Site 1 annual 10-m level wind rose for 1982 shows the prevalent wind direction to be from the west-southwest (WSW on wind rose), with secondary maxima from the south-southwest (SSW on wind rose) and southwest (SW on wind rose). The mean wind speeds associated with these directions were 7.6 mph, 8.5 mph, and 5.6 mph, respectively. These data compare well with the annual wind roses for the previous three years at this site, which all show the prevalent wind direction to be from the west-southwest. At Site 1, the wind directions with the lowest frequency of occurrence, as well as the lowest annual average wind speeds, were in the southeast quadrant during the entire data record.

The Site 2 annual 10-m level wind rose for 1982 shows the prevalent wind direction to be from the southwest, with secondary maxima from the west, west-southwest, and from the south-southwest. The mean wind speeds associated with these directions were 12.1 mph, 8.2 mph, 8.6 mph, and 10.7 mph, respectively. These data are similar to data from previous years, which also show the prevalent wind directions to be from the west and southwest. The wind directions with the lowest frequency of occurrence and the lowest annual average wind speeds at Site 2 are in the southeast quadrant, similar to those found at Site 1.

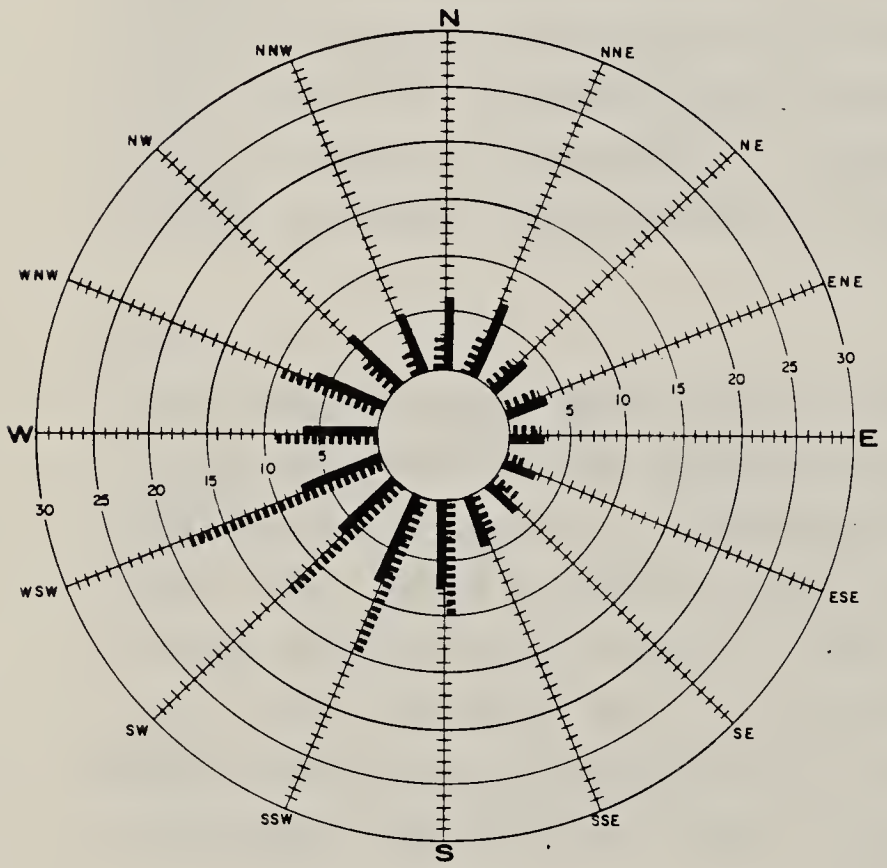
Table 2-18 contains a summary of the absolute maximum and mean hourly wind speed recorded at the two sites during each of the data years. The mean wind speeds for the two sites during the current year were 6.9 mph at the Site 1 10-m level, 9.4 mph at the Site 1 60-m level, and 8.2 mph at Site 2.



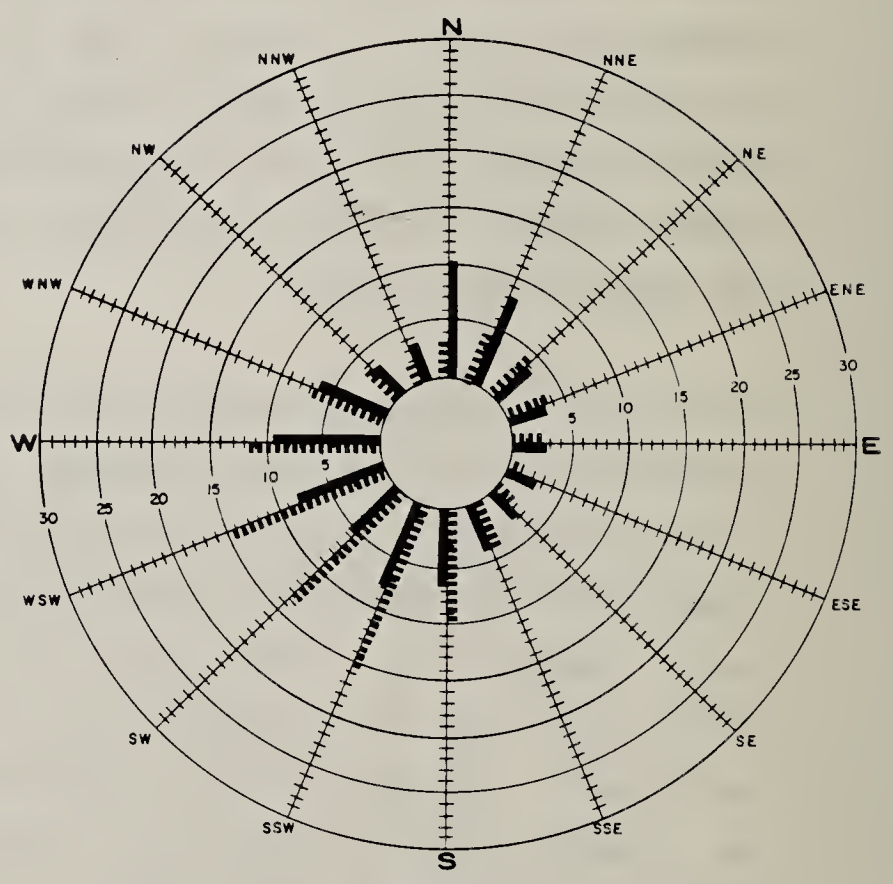

Spring




Summer




Autumn




Winter

Wind Speed (mph)
Wind Direction (%)

Figure 2-7. Seasonal Wind Roses, January-December 1982, Site 1 10-m Level, Tract C-a

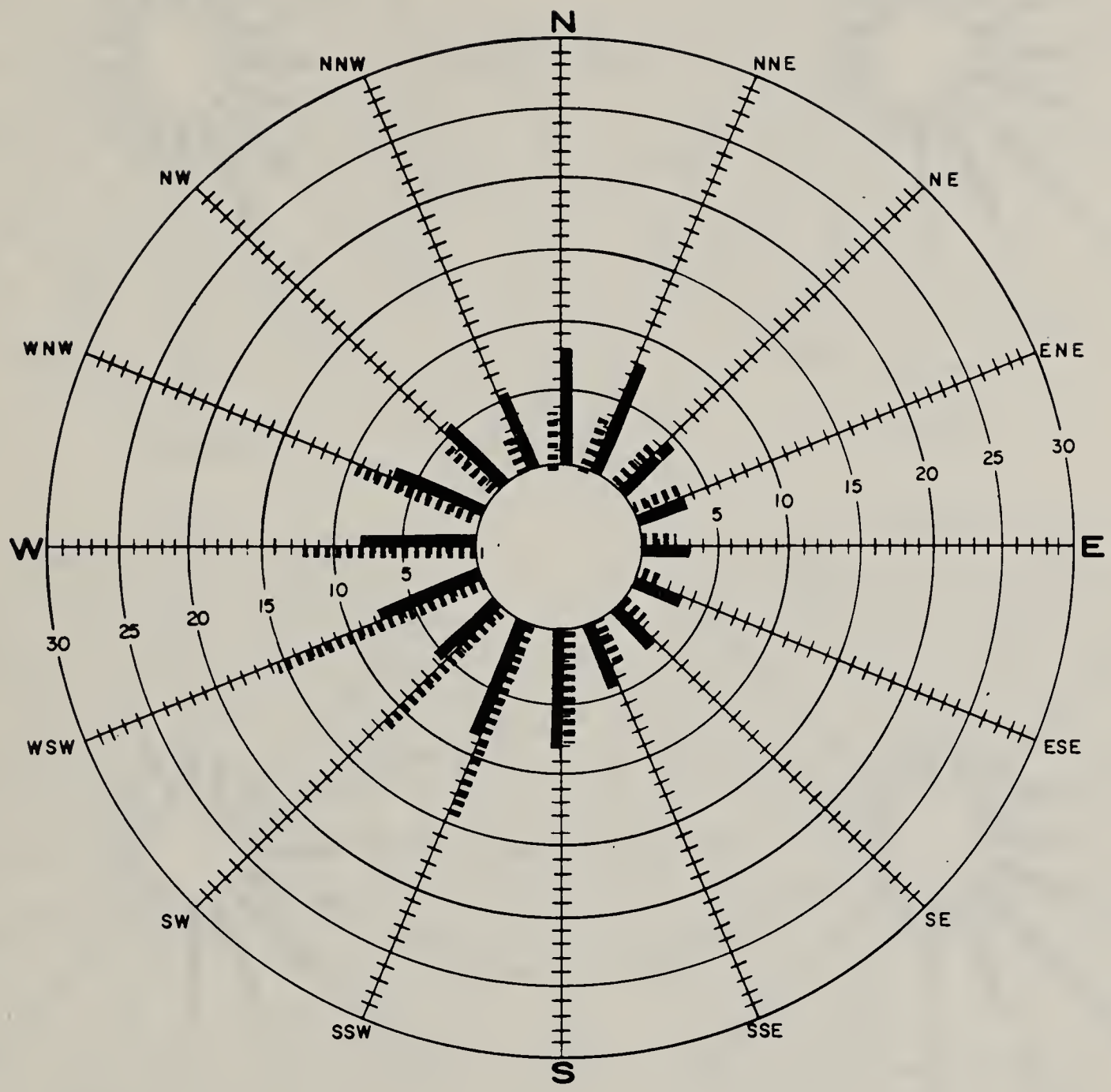
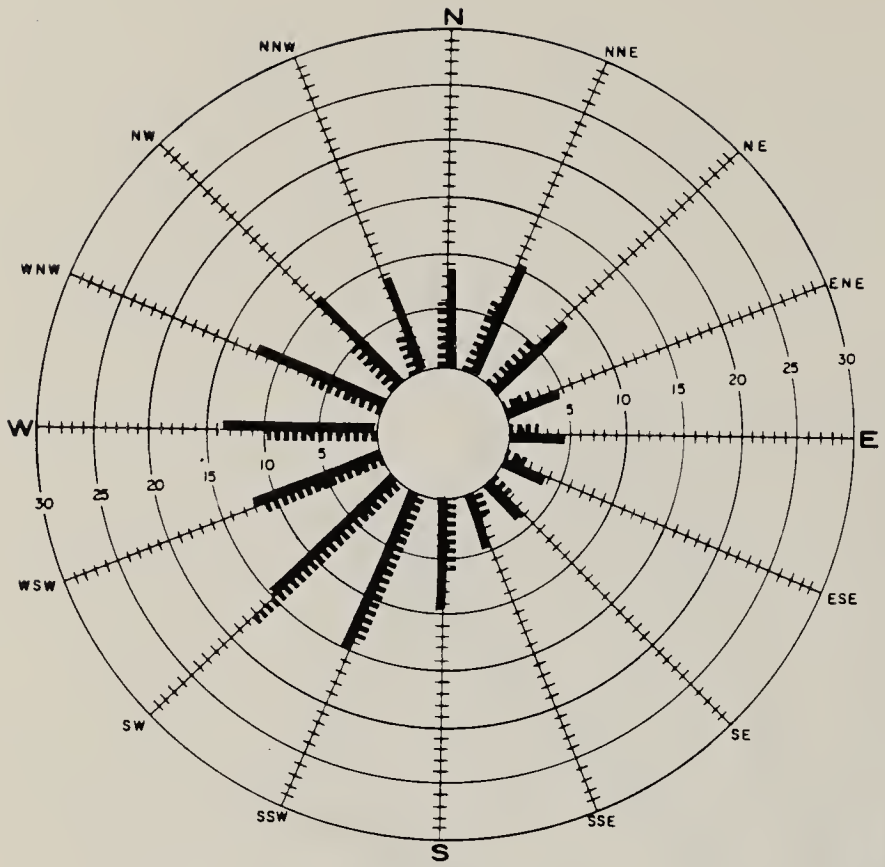
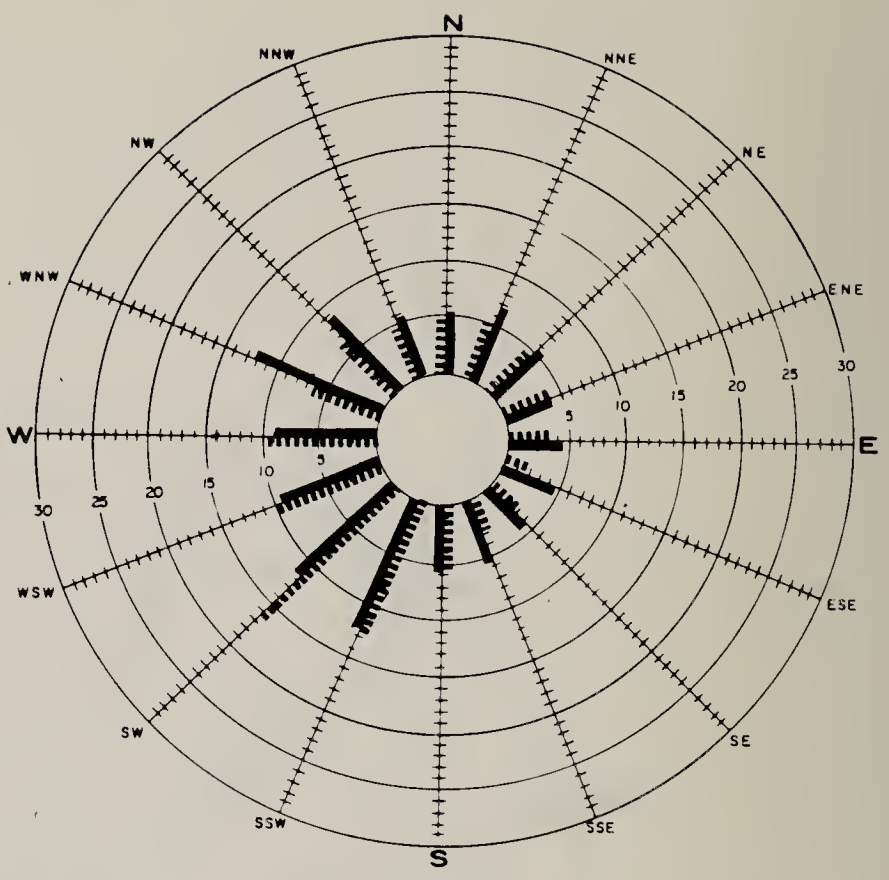


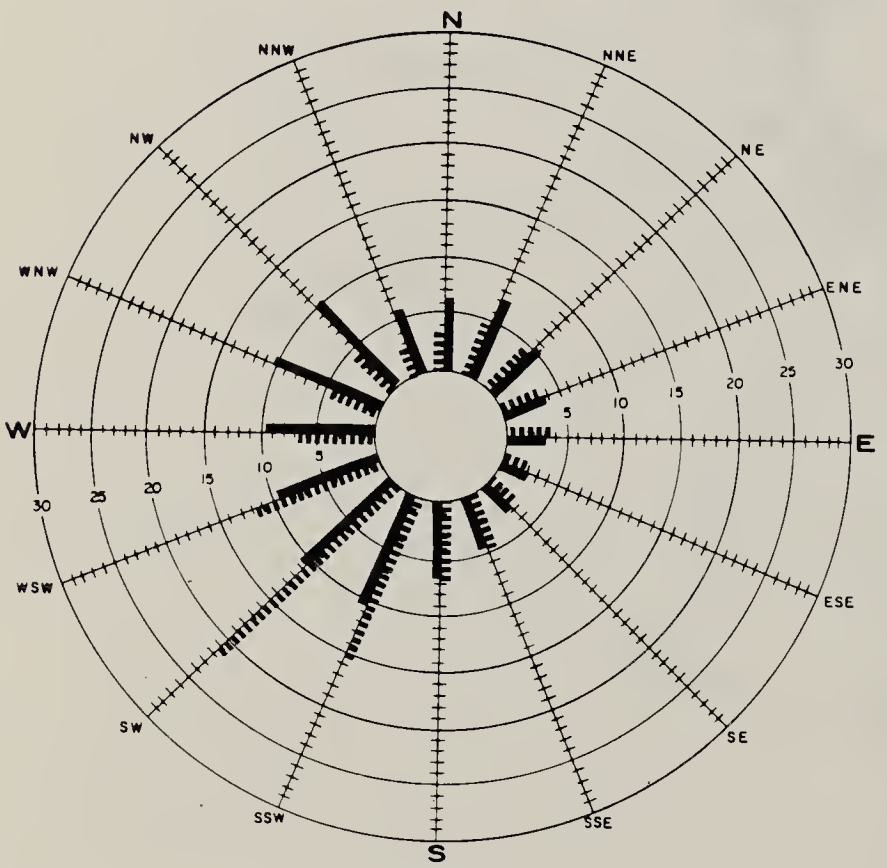

Figure 2-8. Annual Wind Rose, January-December 1982, Site 1 10-m Level, Tract C-a



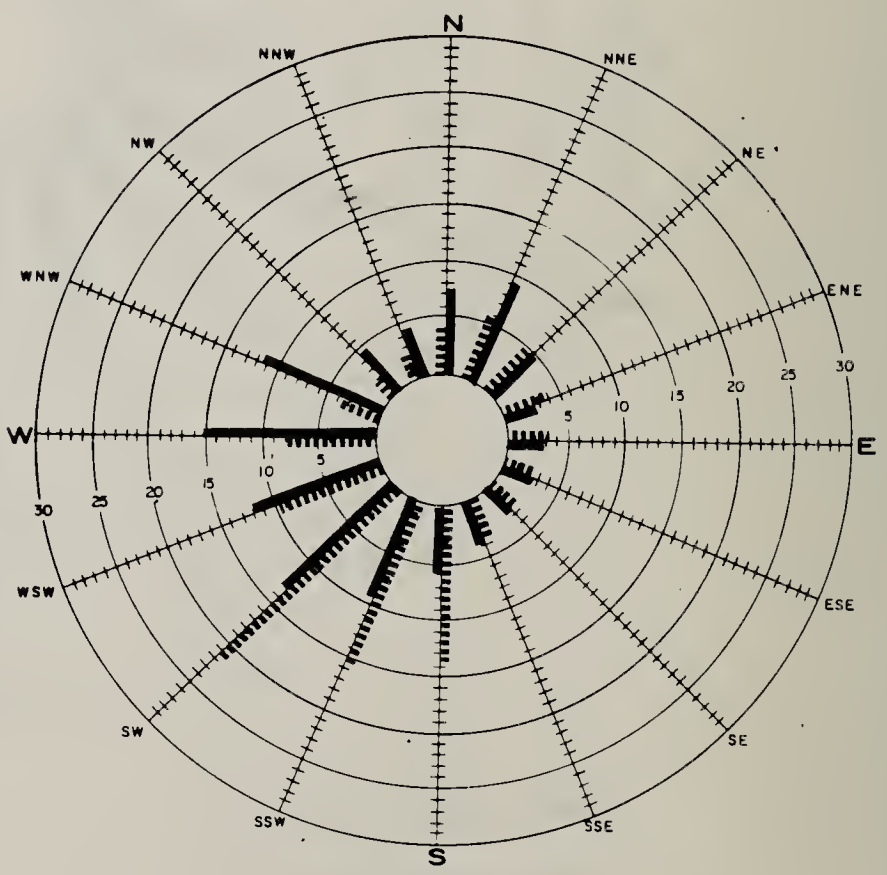

Spring




Summer




Autumn




Winter

Wind Speed (mph)

Wind Direction (%)

Figure 2-9. Seasonal Wind Roses, January-December 1982, Site 1 60-m Level, Tract C-a

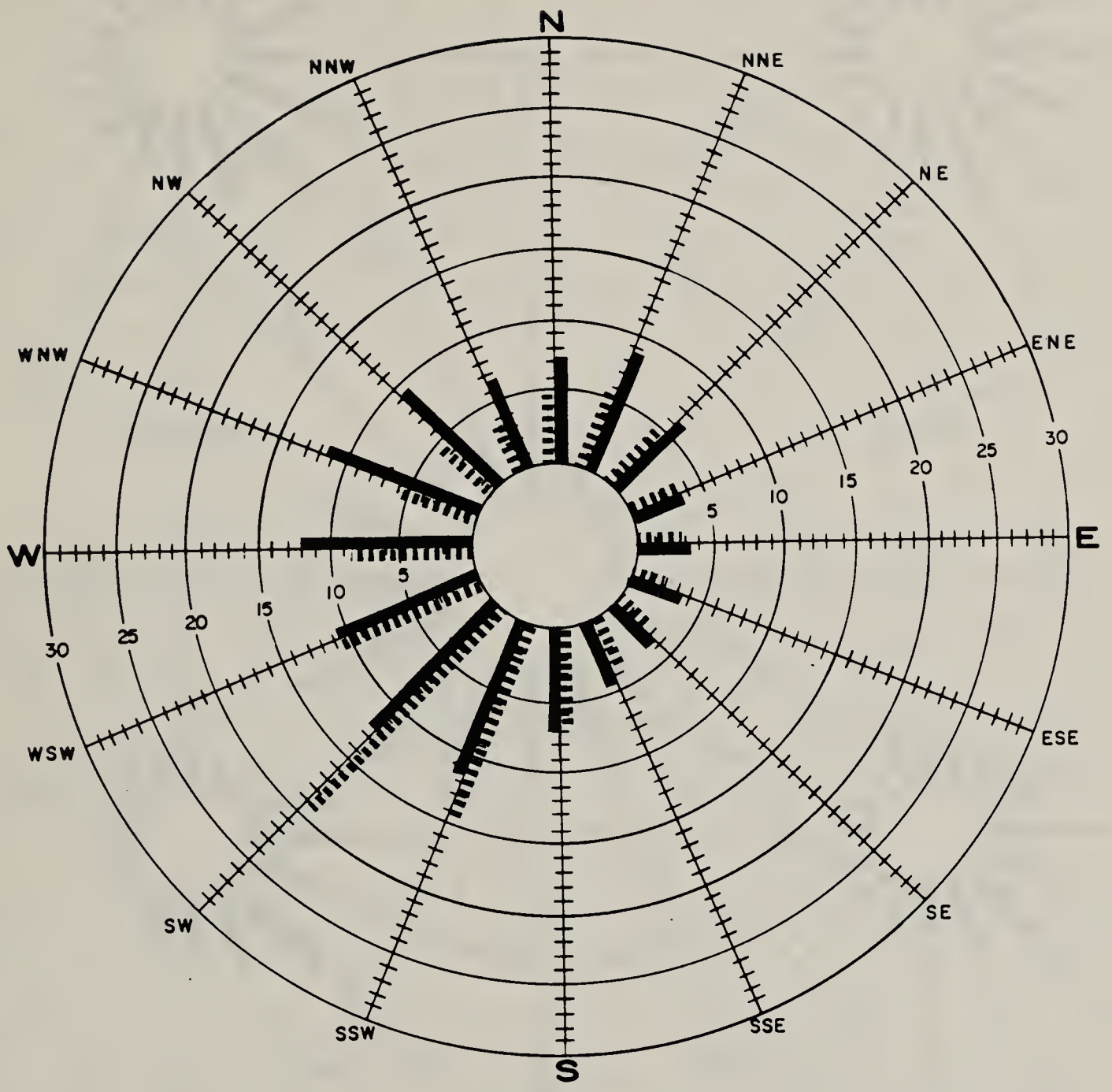
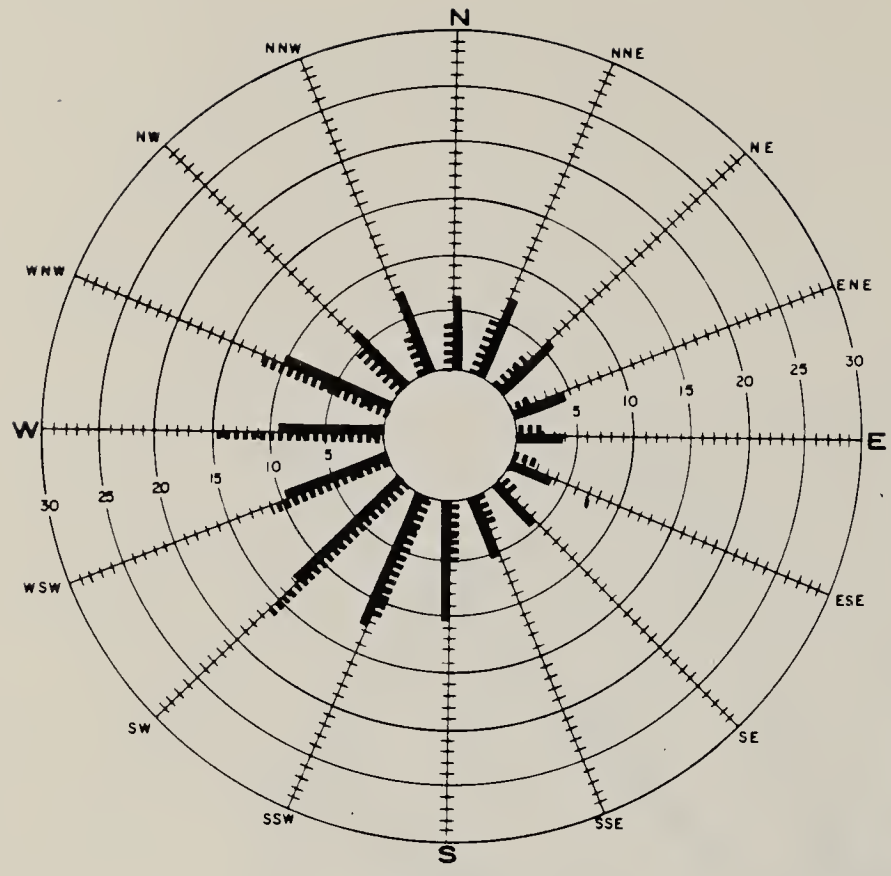
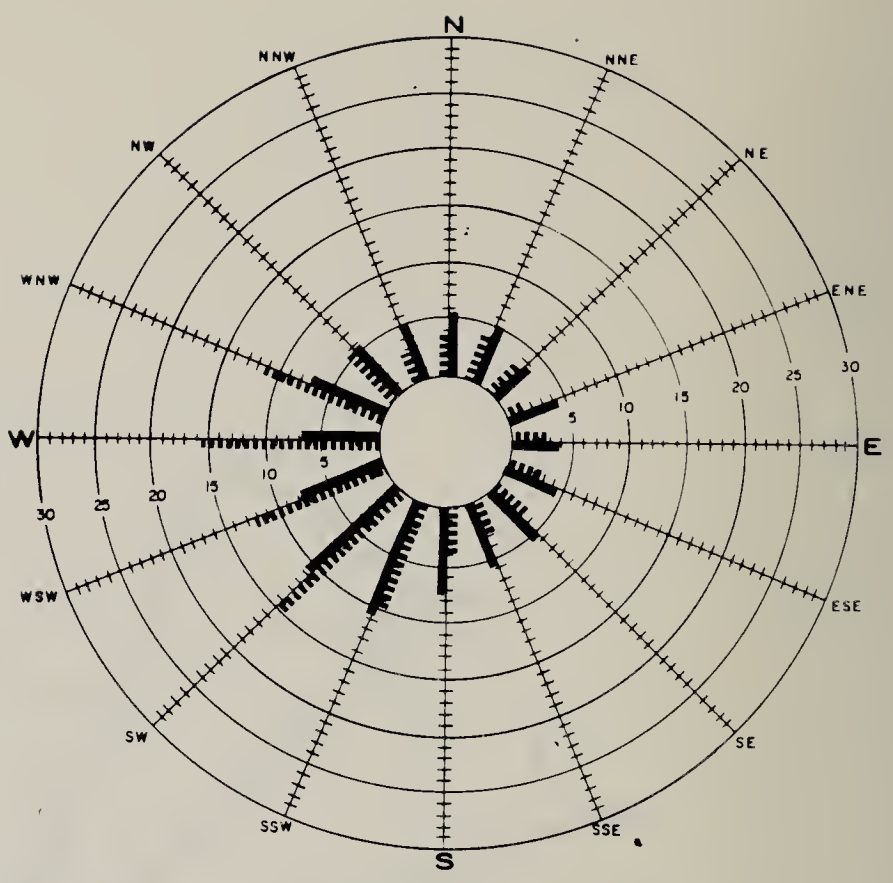


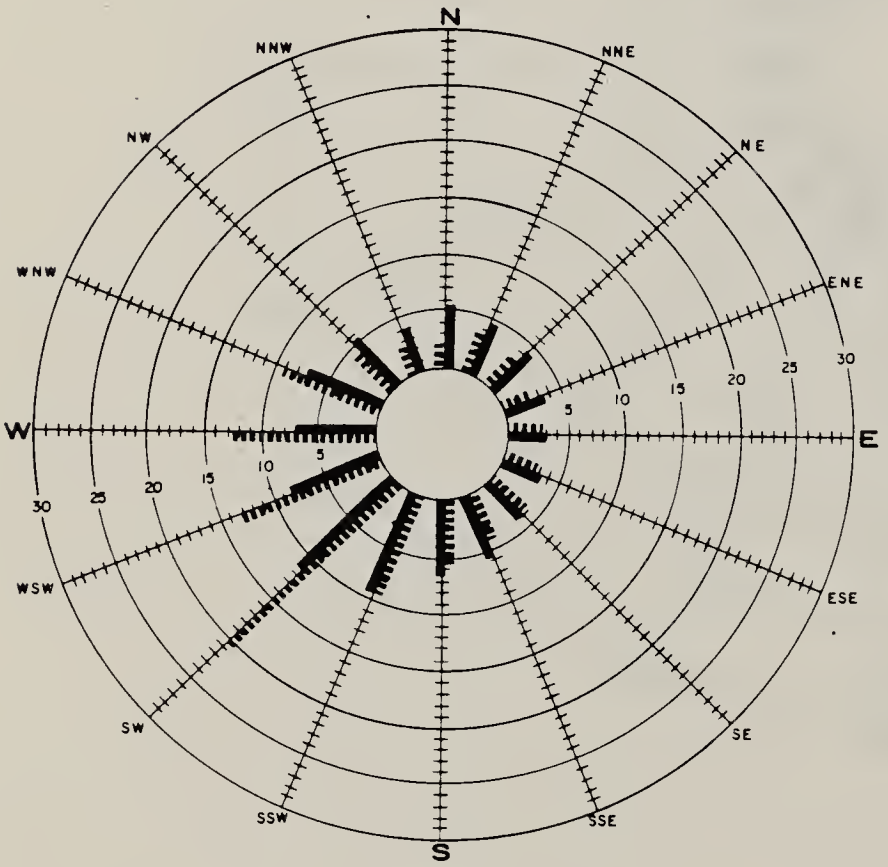

Figure 2-10. Annual Wind Rose, January-December 1982, Site 1 60-m Level, Tract C-a



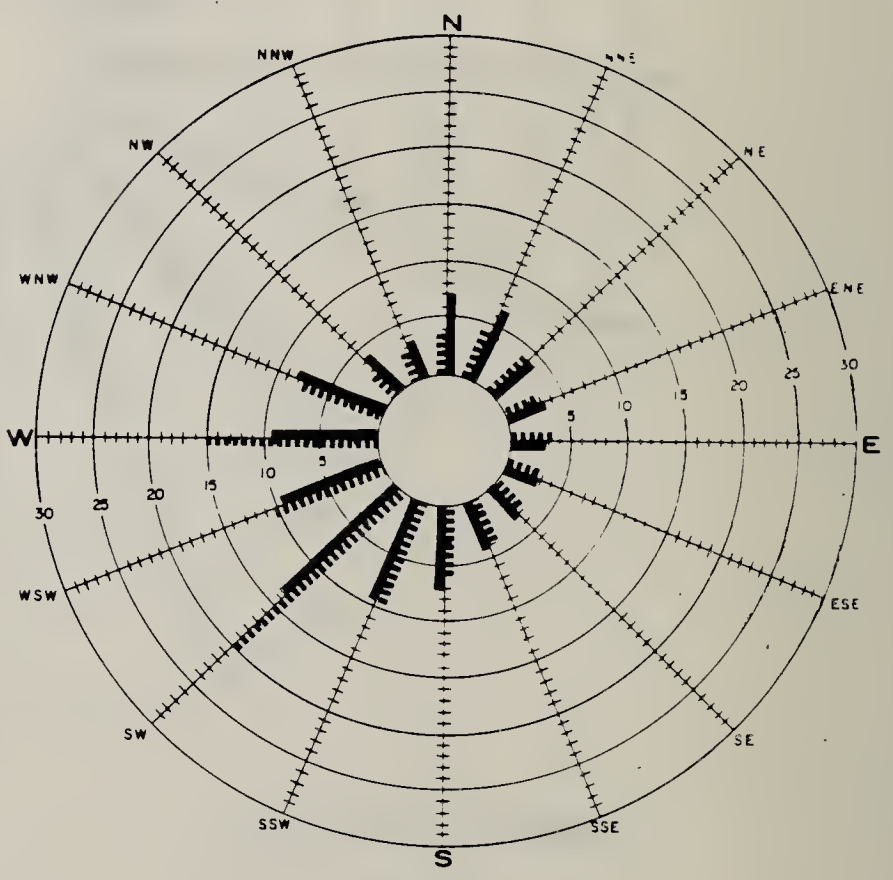

Spring




Summer




Autumn




Winter

Wind Speed (mph)
Wind Direction (%)

Figure 2-11. Seasonal Wind Roses, January-December 1982, Site 2 10-m Level, Tract C-a

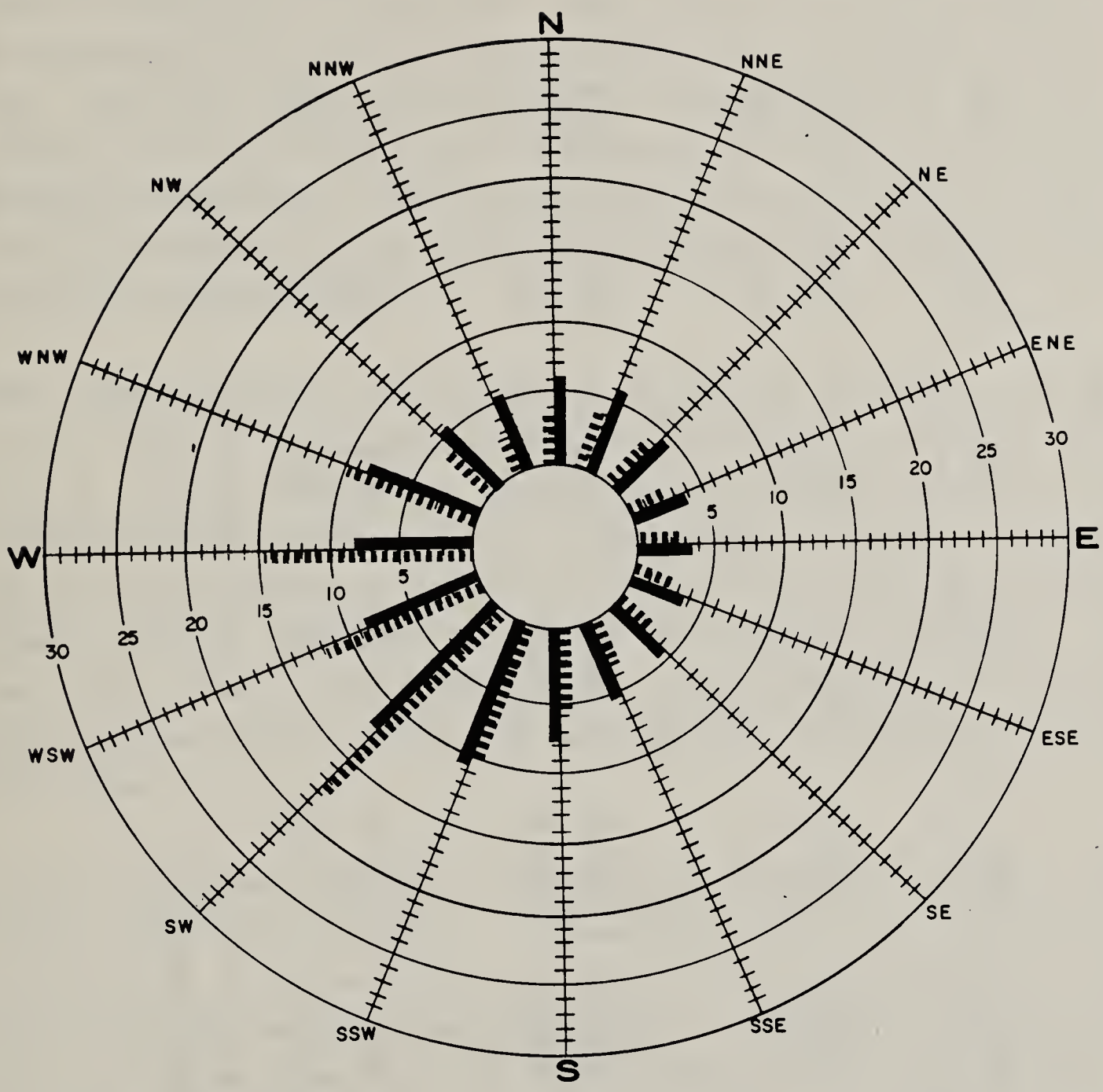



Figure 2-12. Annual Wind Rose, January-December 1982, Site 2 10-m Level, Tract C-a

Table 2-18. Summary of Annual and Mean Wind Speeds (mph) During the Baseline and MDP Periods, Tract C-a.

| Wind Speeds (mph)[1/] | 2/75-1/76 | 2/76-1/77 | 1978 | 1979 | 1980 | 1981 | 1982 | Combined 7-Year Data Set |
|---|---|---|---|---|---|---|---|---|
| Site 1 (10-m level) | | | | | | | | |
| Maximum | 30.8 | 32.3 | 27.2 | 28.7 | 31.6 | 26.1 | 29.6 | 32.3 |
| Mean | 7.7 | 7.2 | 7.3 | 7.3 | 7.3 | 7.0 | 6.9 | 7.2 |
| Site 1 (60-m level) | | | | | | | | |
| Maximum | 43.0 | 56.6 | 41.5 | 38.0 | 40.8 | 33.8 | 37.8 | 56.6 |
| Mean | 10.6 | 10.0 | 10.2 | 9.5 | 10.1 | 9.7 | 9.4 | 9.9 |
| Site 1 (10-m level) | | | | | | | | |
| Maximum | 36.7 | 39.2 | 36.1 | 35.1 | 37.8 | 32.4 | 35.1 | 39.2 |
| Mean | 9.1 | 8.4 | 8.9 | 8.3 | 8.8 | 8.5 | 8.2 | 8.6 |

1/ Values based on hourly averages.

As shown in Table 2-18, there has been little variation in the mean wind speed during the period of record.

Tables 2-19 to 2-21 present the annual frequency of wind direction occurrences by hour for each of the two sites (including the 60-m level at Site 1) during the current year. These tables show the same data as given in the annual wind roses, but also illustrate the variation throughout the day. Each site shows the dominance of westerly winds. At Site 2, for example, the wind blows from five westerly $22.5^{o}$ sectors (south-southwest through west-northwest) almost two-thirds of the time during the entire day. The only exception to this in the early morning, when an upslope (easterly) wind flow is fairly common.

This morning upslope flow (caused by local solar heating of the terrain) can be shown by comparing the relative frequency of easterly winds at Site 2. During midafternoon, easterly winds (from the five $22.5^{o}$ sectors northeast through southeast) occur approximately 14 percent of the time, but are only present an average of 7 percent of the time during the night. However, easterly winds occur 30 percent of the time at 1000 hours, during the peak period of the upslope flow. The predominance of the westerly winds and the morning upslope flow are the major features of the surface wind regime.

Several additional methods for determining atmospheric stability involve measures of wind turbulence. Atmospheric stability estimation by temperature differential has recently been deemphasized in favor of stability estimation from wind measurements. Tables 2-22 and 2-23 present stability classes based upon the standard deviation of the horizontal wind direction fluctuations ( $\sigma_{\theta}$ ), at Sites 1 and 2, respectively. The calculations are based upon recommendations from EPA workshops on air quality modeling (EPA, 1981).

Comparison of Tables 2-22 and 2-23 ( $\sigma_{\theta}$ stability) with Table 2-16 ($\Delta$T stability) reveals considerable differences in the distribution of stability classes. Whereas the "A" and "B" stability classes (unstable

TABLE 2-19. WIND DIRECTION FREQUENCY (%) BY HOUR OF DAY, JANUARY TO DECEMBER 1982, 10 METER TOWER AT SITE 1, TRACT C-A

| HOUR | WIND DIRECTION | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW |
| 1 | 3.2 | 1.4 | 1.4 | 1.1 | 1.1 | 1.1 | 0.9 | 2.3 | 4.0 | 11.2 | 18.7 | 20.1 | 12.9 | 12.9 | 5.5 | 2.0 |
| 2 | 2.9 | 2.3 | 1.7 | 0.3 | 0.9 | 0.6 | 1.1 | 2.0 | 7.2 | 10.6 | 12.9 | 21.6 | 15.8 | 10.3 | 7.2 | 2.6 |
| 3 | 3.2 | 2.9 | 0.6 | 0.6 | . | 0.6 | 1.4 | 1.7 | 7.8 | 12.6 | 14.9 | 19.5 | 14.7 | 11.2 | 5.5 | 2.9 |
| 4 | 2.6 | 2.6 | 0.9 | 0.6 | 0.6 | 0.6 | 0.3 | 3.7 | 7.2 | 9.8 | 16.7 | 21.3 | 14.7 | 9.8 | 6.0 | 2.9 |
| 5 | 4.0 | 1.1 | 0.9 | 1.1 | 0.9 | 0.3 | 0.9 | 2.3 | 7.5 | 11.2 | 15.2 | 19.3 | 14.9 | 10.1 | 6.3 | 4.0 |
| 6 | 4.9 | 1.4 | 0.3 | 2.0 | 1.1 | 1.1 | 2.0 | 2.9 | 5.4 | 12.9 | 14.3 | 20.1 | 11.7 | 11.7 | 5.7 | 2.3 |
| 7 | 5.2 | 4.6 | 2.9 | 1.7 | 0.6 | 1.4 | 2.9 | 4.3 | 10.0 | 16.9 | 9.7 | 16.0 | 10.0 | 8.0 | 2.6 | 3.2 |
| 8 | 3.4 | 4.0 | 5.7 | 7.2 | 3.2 | 2.3 | 4.3 | 8.9 | 10.9 | 12.0 | 8.3 | 12.3 | 7.7 | 5.2 | 3.7 | 0.9 |
| 9 | 1.7 | 2.9 | 7.2 | 9.5 | 7.5 | 3.4 | 4.0 | 6.3 | 11.8 | 12.9 | 6.9 | 9.8 | 7.8 | 4.0 | 2.0 | 2.3 |
| 10 | 2.0 | 6.0 | 8.0 | 10.9 | 6.6 | 2.0 | 2.3 | 5.7 | 10.9 | 13.5 | 6.3 | 13.2 | 8.3 | 2.3 | 1.4 | 0.6 |
| 11 | 2.0 | 5.4 | 10.6 | 7.2 | 3.2 | 2.6 | 2.9 | 3.7 | 10.0 | 16.3 | 8.0 | 11.2 | 9.5 | 4.3 | 2.0 | 1.1 |
| 12 | 3.5 | 3.7 | 6.3 | 6.1 | 3.2 | 1.2 | 1.4 | 2.3 | 10.7 | 16.4 | 8.1 | 13.3 | 11.5 | 5.8 | 2.3 | 4.3 |
| 13 | 3.7 | 5.2 | 4.9 | 5.2 | 4.0 | 2.0 | 1.4 | 1.1 | 9.5 | 17.0 | 8.3 | 13.5 | 13.8 | 7.8 | 1.7 | 0.9 |
| 14 | 4.9 | 4.9 | 4.9 | 6.0 | 1.4 | 0.6 | 1.1 | 0.9 | 12.0 | 15.2 | 5.7 | 12.6 | 14.0 | 8.6 | 4.0 | 3.2 |
| 15 | 2.9 | 5.2 | 6.3 | 3.4 | 1.4 | 0.9 | 0.9 | 0.9 | 10.9 | 20.6 | 7.2 | 9.2 | 14.3 | 7.2 | 4.6 | 4.3 |
| 16 | 2.3 | 6.3 | 4.6 | 2.3 | 2.9 | 0.9 | 0.6 | 2.6 | 12.0 | 18.3 | 9.4 | 9.1 | 9.4 | 8.3 | 7.4 | 3.7 |
| 17 | 4.0 | 6.3 | 3.7 | 2.0 | 4.0 | 1.7 | 1.7 | 2.3 | 7.2 | 19.2 | 10.6 | 10.6 | 7.7 | 10.9 | 4.3 | 3.7 |
| 18 | 6.0 | 4.3 | 4.3 | 1.1 | 2.0 | 1.4 | 1.4 | 1.7 | 6.9 | 20.3 | 11.2 | 9.5 | 10.3 | 8.9 | 6.9 | 3.7 |
| 19 | 2.6 | 4.3 | 2.0 | 0.9 | 2.0 | 1.4 | 0.9 | 3.2 | 5.7 | 15.8 | 12.9 | 11.5 | 13.2 | 10.3 | 9.7 | 3.7 |
| 20 | 3.7 | 3.2 | 0.3 | 1.1 | 0.9 | 0.6 | 1.7 | 2.3 | 4.0 | 12.6 | 17.2 | 15.8 | 11.5 | 15.8 | 6.9 | 2.6 |
| 21 | 4.0 | 2.9 | 1.1 | 1.4 | 0.3 | 0.6 | 1.7 | 3.4 | 3.7 | 13.5 | 10.9 | 23.2 | 13.8 | 14.3 | 4.0 | 1.1 |
| 22 | 4.0 | 3.4 | 1.7 | . | . | 0.6 | 0.9 | 2.9 | 5.2 | 13.2 | 12.9 | 20.9 | 14.6 | 14.9 | 2.9 | 2.0 |
| 23 | 5.7 | 2.9 | 0.6 | 0.3 | 0.6 | . | 2.3 | 1.1 | 6.0 | 11.7 | 14.0 | 20.9 | 14.6 | 12.3 | 5.2 | 1.7 |
| 24 | 2.9 | 2.6 | 0.9 | . | 0.6 | 0.6 | 0.9 | 3.2 | 4.6 | 12.0 | 16.3 | 20.3 | 16.0 | 12.3 | 4.0 | 2.9 |
| MEAN | 3.5 | 3.5 | 3.5 | 3.5 | 2.0 | 1.2 | 1.7 | 3.0 | 8.0 | 14.4 | 11.5 | 15.6 | 12.2 | 9.5 | 4.7 | 2.6 |

TABLE 2-20. WIND DIRECTION FREQUENCY (%) BY HOUR OF DAY, JANUARY TO DECEMBER 1982, 60 METER TOWER AT SITE 1, TRACT C-A

| HOUR | WIND DIRECTION N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.4 | 5.4 | 4.0 | 2.0 | 2.6 | 0.3 | 2.0 | 2.0 | 7.4 | 14.6 | 20.6 | 12.3 | 9.1 | 3.4 | 2.9 | 4.0 |
| 2 | 7.7 | 4.9 | 5.4 | 1.4 | 0.6 | 2.3 | 3.1 | 3.1 | 6.9 | 14.3 | 20.0 | 10.0 | 8.0 | 4.9 | 5.1 | 2.3 |
| 3 | 7.7 | 6.0 | 5.7 | 2.0 | 1.7 | 0.6 | 2.9 | 2.0 | 7.1 | 14.9 | 21.1 | 10.0 | 8.0 | 4.6 | 3.7 | 2.0 |
| 4 | 6.9 | 6.6 | 2.3 | 1.4 | 2.6 | 2.0 | 1.4 | 2.3 | 8.3 | 13.4 | 20.6 | 12.0 | 8.6 | 4.9 | 2.9 | 4.0 |
| 5 | 8.3 | 6.0 | 3.1 | 2.3 | 1.7 | 1.1 | 2.9 | 3.1 | 9.7 | 12.0 | 20.3 | 11.4 | 8.6 | 4.0 | 2.6 | 2.9 |
| 6 | 6.0 | 6.6 | 3.1 | 2.3 | 1.1 | 1.1 | 2.0 | 4.9 | 10.0 | 13.1 | 16.6 | 11.7 | 8.6 | 3.4 | 4.6 | 4.9 |
| 7 | 4.3 | 7.1 | 4.6 | 3.1 | 0.9 | 2.3 | 1.7 | 5.7 | 9.1 | 16.0 | 16.6 | 11.1 | 7.4 | 4.3 | 2.3 | 3.4 |
| 8 | 4.3 | 4.9 | 5.1 | 5.1 | 4.9 | 2.9 | 5.4 | 8.6 | 9.7 | 11.4 | 16.6 | 6.9 | 7.4 | 3.1 | 2.3 | 1.4 |
| 9 | 3.7 | 3.2 | 5.2 | 8.9 | 7.7 | 3.4 | 3.7 | 4.0 | 11.2 | 13.8 | 15.8 | 9.5 | 5.7 | 1.7 | 2.0 | 0.6 |
| 10 | 0.9 | 4.6 | 7.1 | 5.7 | 10.0 | 3.7 | 4.0 | 3.4 | 8.3 | 14.6 | 14.9 | 11.4 | 8.0 | 1.7 | 1.1 | 0.6 |
| 11 | 1.1 | 5.4 | 6.3 | 6.0 | 5.7 | 3.4 | 1.7 | 4.0 | 6.6 | 14.6 | 16.9 | 13.4 | 7.7 | 3.1 | 2.0 | 2.0 |
| 12 | 4.0 | 2.3 | 5.2 | 5.4 | 4.6 | 2.3 | 1.7 | 2.6 | 1.7 | 15.8 | 18.9 | 14.9 | 9.2 | 4.9 | 2.6 | 4.0 |
| 13 | 2.9 | 4.3 | 4.9 | 3.7 | 4.0 | 2.6 | 2.6 | 1.7 | 1.4 | 16.4 | 19.0 | 13.2 | 11.5 | 8.0 | 2.6 | 1.1 |
| 14 | 4.6 | 4.6 | 4.6 | 4.0 | 3.7 | 1.1 | 1.1 | 0.6 | 3.4 | 16.3 | 15.5 | 12.6 | 14.0 | 6.9 | 4.6 | 2.3 |
| 15 | 2.3 | 5.1 | 5.7 | 3.7 | 1.4 | 0.6 | 1.4 | 1.4 | 3.1 | 15.7 | 19.4 | 10.9 | 12.0 | 8.9 | 4.3 | 4.0 |
| 16 | 2.0 | 4.0 | 4.8 | 4.0 | 3.4 | 1.4 | 0.9 | 1.4 | 3.7 | 17.0 | 21.0 | 7.4 | 10.8 | 7.1 | 7.1 | 4.0 |
| 17 | 3.7 | 5.1 | 6.0 | 2.6 | 4.0 | 2.0 | 1.1 | 1.4 | 4.3 | 12.9 | 23.1 | 7.7 | 7.4 | 9.1 | 6.3 | 3.1 |
| 18 | 3.4 | 6.0 | 6.3 | 2.9 | 1.7 | 2.3 | 1.1 | 2.6 | 4.0 | 14.6 | 21.4 | 5.7 | 9.4 | 7.4 | 7.7 | 3.4 |
| 19 | 4.3 | 4.8 | 4.6 | 2.6 | 1.4 | 2.3 | 2.0 | 3.1 | 4.3 | 11.7 | 21.9 | 7.1 | 8.3 | 6.3 | 10.3 | 5.1 |
| 20 | 4.3 | 7.1 | 3.4 | 1.7 | 1.4 | 0.6 | 1.1 | 2.0 | 7.7 | 12.8 | 22.2 | 7.7 | 6.6 | 7.4 | 9.4 | 4.6 |
| 21 | 2.8 | 6.0 | 4.8 | 2.0 | 0.3 | 1.7 | 2.0 | 5.4 | 7.4 | 14.8 | 18.8 | 9.1 | 6.8 | 7.4 | 5.7 | 4.8 |
| 22 | 4.6 | 6.8 | 3.4 | 2.3 | 2.0 | 0.9 | 2.3 | 3.7 | 8.3 | 14.0 | 17.7 | 12.5 | 7.1 | 6.8 | 3.7 | 4.0 |
| 23 | 4.3 | 6.8 | 4.3 | 2.3 | 1.1 | 1.1 | 2.6 | 1.7 | 7.4 | 13.1 | 18.8 | 14.5 | 7.7 | 4.0 | 5.7 | 4.6 |
| 24 | 5.1 | 7.4 | 3.1 | 1.4 | 1.7 | 1.7 | 2.8 | 2.3 | 8.5 | 11.7 | 20.5 | 10.5 | 9.4 | 6.6 | 3.4 | 3.7 |
| MEAN | 4.4 | 4.4 | 4.4 | 4.4 | 2.9 | 1.8 | 2.2 | 3.0 | 6.7 | 14.1 | 19.1 | 10.6 | 8.6 | 5.4 | 4.4 | 3.2 |

TABLE 2-21. WIND DIRECTION FREQUENCY (%) BY HOUR OF DAY, JANUARY TO DECEMBER 1982, 10 METER TOWER AT SITE 2, TRACT C-A

| HOUR | WIND DIRECTION N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.0 | 1.7 | 1.7 | 0.8 | 1.4 | 1.7 | 2.5 | 2.3 | 3.1 | 9.9 | 18.7 | 13.6 | 21.5 | 10.5 | 4.8 | 3.7 |
| 2 | 3.4 | 3.1 | 3.4 | . | 1.4 | 1.7 | 2.3 | 4.0 | 5.1 | 8.2 | 18.1 | 12.7 | 19.3 | 9.9 | 3.4 | 4.0 |
| 3 | 4.0 | 2.8 | 2.5 | 1.7 | 0.8 | 1.4 | 1.4 | 3.1 | 5.1 | 9.3 | 20.1 | 11.3 | 18.1 | 11.3 | 3.7 | 3.4 |
| 4 | 3.4 | 2.8 | 1.7 | 0.8 | 2.5 | 0.8 | 1.4 | 2.8 | 4.5 | 8.8 | 18.4 | 12.4 | 20.9 | 11.0 | 4.5 | 3.1 |
| 5 | 2.8 | 2.3 | 2.5 | 1.7 | 0.8 | 1.1 | 1.7 | 4.5 | 7.1 | 9.0 | 14.1 | 14.4 | 17.5 | 13.6 | 3.4 | 3.4 |
| 6 | 4.5 | 3.1 | 1.7 | 1.1 | 0.6 | 0.8 | 3.7 | 4.0 | 5.6 | 8.8 | 13.3 | 14.4 | 20.1 | 8.8 | 5.4 | 4.2 |
| 7 | 5.6 | 3.7 | 2.0 | 1.1 | 3.4 | 2.0 | 4.0 | 4.5 | 5.6 | 9.0 | 13.6 | 13.0 | 15.5 | 9.6 | 3.7 | 3.7 |
| 8 | 4.0 | 5.4 | 3.7 | 2.5 | 5.1 | 4.8 | 6.2 | 6.5 | 8.8 | 7.9 | 13.8 | 8.5 | 7.9 | 8.2 | 4.8 | 2.0 |
| 9 | 3.5 | 5.5 | 2.9 | 4.3 | 6.6 | 7.2 | 6.3 | 6.1 | 6.6 | 10.1 | 12.1 | 12.4 | 7.2 | 4.3 | 2.0 | 2.9 |
| 10 | 2.1 | 6.2 | 5.3 | 6.2 | 5.3 | 7.9 | 5.3 | 3.5 | 7.0 | 9.1 | 15.5 | 8.5 | 12.6 | 2.6 | 2.1 | 0.9 |
| 11 | 3.8 | 5.8 | 6.9 | 2.3 | 5.2 | 5.5 | 2.6 | 2.3 | 3.8 | 10.1 | 20.2 | 11.0 | 12.1 | 4.3 | 3.2 | 0.9 |
| 12 | 3.7 | 5.5 | 4.9 | 2.3 | 4.3 | 3.4 | 2.9 | 2.0 | 2.6 | 11.8 | 18.4 | 12.1 | 11.2 | 9.8 | 2.9 | 2.3 |
| 13 | 3.8 | 4.4 | 4.7 | 3.2 | 4.7 | 1.8 | 2.3 | 0.9 | 3.5 | 11.4 | 17.8 | 14.6 | 10.5 | 12.3 | 1.8 | 2.3 |
| 14 | 4.6 | 4.6 | 4.9 | 2.9 | 3.2 | 1.4 | 1.7 | 2.0 | 4.3 | 9.5 | 20.3 | 8.9 | 14.0 | 11.2 | 3.7 | 2.9 |
| 15 | 2.0 | 5.8 | 2.9 | 2.9 | 2.9 | 2.0 | 1.2 | 1.4 | 3.7 | 11.2 | 24.5 | 8.9 | 11.5 | 11.5 | 5.2 | 2.3 |
| 16 | 3.4 | 3.4 | 5.7 | 3.4 | 2.8 | 1.1 | 2.0 | 2.3 | 3.4 | 11.6 | 23.6 | 7.4 | 8.8 | 12.5 | 6.2 | 2.3 |
| 17 | 4.2 | 5.4 | 5.1 | 4.5 | 1.4 | 2.5 | 2.0 | 2.8 | 5.6 | 8.2 | 22.0 | 9.0 | 9.3 | 11.6 | 4.2 | 2.0 |
| 18 | 2.8 | 5.4 | 5.7 | 2.3 | 0.9 | 2.0 | 2.3 | 4.0 | 5.7 | 9.9 | 19.9 | 10.5 | 8.0 | 9.7 | 6.5 | 4.5 |
| 19 | 3.4 | 3.1 | 3.7 | 1.7 | 2.5 | 1.7 | 1.7 | 4.8 | 3.9 | 9.9 | 20.0 | 9.3 | 11.3 | 10.1 | 7.9 | 5.1 |
| 20 | 3.1 | 4.5 | 2.3 | 1.1 | 0.8 | 0.8 | 1.1 | 4.5 | 5.4 | 11.3 | 17.8 | 13.9 | 13.0 | 13.6 | 5.7 | 0.8 |
| 21 | 2.5 | 4.2 | 2.0 | 0.8 | 1.1 | 0.6 | 2.5 | 2.5 | 5.1 | 12.7 | 16.9 | 15.8 | 15.0 | 13.0 | 4.2 | 0.8 |
| 22 | 2.3 | 3.7 | 2.0 | 0.6 | 0.8 | 1.1 | 2.0 | 2.5 | 5.1 | 11.9 | 14.7 | 13.9 | 22.7 | 9.6 | 4.2 | 2.8 |
| 23 | 3.1 | 4.2 | 1.7 | 1.1 | 0.8 | 1.7 | 0.6 | 1.7 | 4.5 | 12.4 | 16.4 | 14.4 | 20.3 | 8.8 | 4.8 | 3.4 |
| 24 | 2.5 | 3.4 | 1.4 | 1.1 | 1.1 | 0.8 | 2.0 | 2.5 | 6.2 | 8.8 | 19.8 | 14.7 | 20.3 | 9.9 | 4.0 | 1.4 |
| MEAN | 3.4 | 3.4 | 3.4 | 3.4 | 2.5 | 2.3 | 2.6 | 3.2 | 5.1 | 10.0 | 17.9 | 11.9 | 14.5 | 9.9 | 4.3 | 2.7 |

Table 2-22. Monthly, Seasonal, and Annual Occurrence (hours) of Stability Classes based upon the Site 1 10-m Horizontal Wind Direction Fluctuation ($\sigma_\theta$), 1982, Tract C-a.

| | Stability Index | | | | | | |
|---|---|---|---|---|---|---|---|
| Period | A | B | C | D | E | F | Total |
| January | 63 | 63 | 77 | 336 | 102 | 103 | 744 |
| February | 47 | 60 | 81 | 237 | 148 | 97 | 670 |
| March | 56 | 74 | 152 | 275 | 124 | 63 | 744 |
| April | 89 | 90 | 107 | 252 | 111 | 47 | 696 |
| May | 76 | 107 | 145 | 246 | 126 | 43 | 743 |
| June | 125 | 87 | 138 | 207 | 94 | 69 | 720 |
| July | 127 | 118 | 131 | 193 | 129 | 46 | 744 |
| August | 134 | 96 | 94 | 197 | 143 | 79 | 743 |
| September | 56 | 43 | 65 | 152 | 90 | 53 | 459 |
| October | 49 | 74 | 96 | 245 | 168 | 88 | 720 |
| November | 24 | 58 | 113 | 245 | 147 | 108 | 695 |
| December | 40 | 45 | 81 | 288 | 155 | 81 | 690 |
| Winter | 150 | 168 | 239 | 861 | 405 | 281 | 2104 |
| Spring | 221 | 271 | 404 | 773 | 361 | 153 | 2183 |
| Summer | 386 | 301 | 363 | 597 | 366 | 194 | 2207 |
| Fall | 129 | 175 | 274 | 642 | 405 | 249 | 1874 |
| Annual | 886 | 915 | 1280 | 2873 | 1537 | 877 | 8368 |

Table 2-23. Monthly, Seasonal, and Annual Occurrence (hours) of Stability Classes based upon the Site 2 10-m Horizontal Wind Direction Fluctuation ($\sigma_\theta$), 1982, Tract C-a

| Period | Stability Index | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | Total |
| January | 23 | 17 | 44 | 336 | 241 | 48 | 709 |
| February | 42 | 42 | 70 | 214 | 192 | 54 | 614 |
| March | 35 | 28 | 69 | 403 | 175 | 25 | 735 |
| April | 85 | 51 | 85 | 322 | 146 | 24 | 713 |
| May | 74 | 55 | 142 | 286 | 164 | 15 | 736 |
| June | 104 | 53 | 115 | 217 | 188 | 33 | 710 |
| July | 114 | 60 | 120 | 238 | 177 | 29 | 738 |
| August | 102 | 66 | 94 | 211 | 169 | 48 | 690 |
| September | 55 | 48 | 80 | 266 | 195 | 46 | 690 |
| October | 43 | 44 | 85 | 256 | 223 | 65 | 716 |
| November | 38 | 29 | 53 | 330 | 163 | 79 | 692 |
| December | 47 | 34 | 64 | 292 | 181 | 70 | 688 |
| Winter | 112 | 93 | 178 | 842 | 614 | 172 | 2011 |
| Spring | 194 | 134 | 296 | 1011 | 485 | 64 | 2184 |
| Summer | 320 | 179 | 329 | 666 | 534 | 110 | 2138 |
| Fall | 136 | 121 | 218 | 852 | 581 | 190 | 2098 |
| Annual | 762 | 527 | 1021 | 3371 | 2214 | 536 | 8431 |

atmospheric conditions) are almost nonexistent in the winter at Site 1 based on ΔT stability (14 out of a possible 2104 hours during the season), these classes are relatively common based on $\sigma_\theta$ stability (318 hours during the season). More importantly, the annual summaries show a significant shift from stable to neutral and unstable atmospheric conditions using stability (i.e., at Site 1 ΔT stability shows 3565 hours of "F" stability (stable atmospheric conditions), whereas $\sigma_\theta$ stability shows only 1537 hours of "F" stability). The number of hours of stable atmospheric conditions (and their persistence) is important because air quality modeling generally shows the greatest impacts during stable conditions.

## D. Precipitation

### 1. Objectives

Precipitation is recorded to provide data on the moisture availability for plant growth and revegetation.

### 2. Methods

The methods followed for collection of these data were described in MDP Report 2 (RBOSC 1978a).

### 3. Results and Discussion

Precipitation data from the three types of measuring devices for the period June-December 1981 are included in Appendix 2-2.3. Snow depth measurements taken during the current year are presented in Appendix 2-2.4 There is a substantial difference in the reported precipitation between the type of gauges installed at each site. The weighing bucket gauges generally have been recording somewhat higher precipitation amounts than the tipping bucket gauges. The wedge gauge data have been reasonably close to the results from the weighing bucket gauges.

Table 2-24 presents the monthly, seasonal, and annual precipitation at Sites 1, 2, and 3 for the current year. The table is compiled from data which are collected by tipping bucket gauges, weighing bucket gauges, and wedge gauges. Precipitation measured at the three sites during the current year ranged from 12.94 to 16.36 inches. Although the natural variability of precipitation is high in semi-arid regions, a substantial part of the range in values is probably due to different exposures and capture efficiencies of the gauges.

The weighing bucket gauges are thought to produce the most representative precipitation data, due to a better exposure and the improvement in winter capture efficiency through the use of snow shields. The tipping bucket gauges have historically recorded lower amounts of precipitation than other gauges, which may be due to a less efficient capture and measurement technique (RBOSC 1980).

Table 2-25 presents the results of the precipitation measurements collected onsite over the past five years. Based on this record, 1982 was the second wettest year. The best estimate of annual precipitation, based on data from the weighing bucket gauges, indicates that precipitation totalled approximately 13 inches in 1978 and 1979, 12 inches in 1980, 17 inches in 1981, and 16 inches in 1982. Table 2-26 shows the number of days with precipitation and the largest precipitation event for each month at Tract C-a. The largest event released approximately 2.3 inches of precipitation over 6 days in September. Precipitation (at least 0.01 inch) was measured on an average of 10 days per month.

The wettest month during the current year was September, when approximately 25 percent of the total annual precipitation fell. For the period 1978-80, spring was the wettest season, but for the last two years fall has been the wettest season. A correlation analysis between the seasonal and the annual precipitation for the five years of record produced some interesting results: the total annual precipitation collected by the Site 1 weighing bucket gauge was highly correlated with the fall precipitation ($r=0.95$) and reasonably well correlated with the summer precipitation ($r=0.65$), but

Table 2-24. Monthly, Seasonal, and Annual Precipitaion (inches) at Sites 1, 2, and 3 from available Tipping Bucket Gauge, Weighing Bucket Gauge, and Wedge Gauge Data at Tract C-a for the period January - December 1982.

| Month | Site 1 | | | Site 2 | | | Site 3 |
|---|---|---|---|---|---|---|---|
| | Tipping Bucket Gauge | Weighing Bucket Gauge | Wedge Gauge | Tipping Bucket Gauge | Weighing Bucket Gauge | Wedge Gauge | Wedge Gauge |
| January | 0.39 | 1.18 | 1.07 | 0.32 | 1.11 | 0.58 | 0.66 |
| February | 0.16 | 0.45 | 0.39 | 0.16 | 0.38 | 0.35 | 0.27 |
| March | 0.50 | 0.91 | 0.92 | 0.50 | 0.92 | 0.65 | 0.60 |
| April | 0.45 | 0.70 | 0.60 | 0.45 | 0.58 | 0.33 | 0.40 1/ |
| May | 1.05 | 1.44 | 1.49 | 1.19 | 1.26 | 1.49 | 1.77 |
| June | 0.12 | 0.11 | 0.11 | 0.17 | 0.18 | 0.09 | 0.15 |
| July | 1.19 | 0.92 | 1.32 | 0.52 | 0.43 | 0.57 | 1.20 |
| August | 1.24 | 2.05 | 1.80 | 1.71 | 1.71 | 1.94 | 1.28 |
| September | NA | 4.33 | 4.81 | 3.40 | 4.17 | 3.75 | 3.45 |
| October | NA | 2.10 | 2.06 | NA | 1.99 | 1.92 | 1.74 |
| November | 0.54 | 1.21 | 0.93 | 0.42 | 1.07 | 0.96 | 0.72 |
| December | 0.47 | 0.96 | 0.78 | 0.50 | 0.98 | 0.90 | 0.70 |
| Seasonal | | | | | | | |
| Winter (Dec, Jan, Feb) | 1.02 | 2.59 | 2.24 | 0.98 | 2.47 | 1.83 | 1.63 |
| Spring (Mar, Apr, May) | 2.00 | 3.05 | 3.01 | 2.14 | 2.76 | 2.47 | 2.77 |
| Summer (Jun, Jul, Aug) | 2.55 | 3.08 | 3.23 | 2.40 | 2.32 | 2.60 | 2.63 |
| Fall (Sep, Oct, Nov) | NA | 7.64 | 7.80 | NA | 7.23 | 6.63 | 5.91 |
| Annual | NA | 16.36 | 16.28 | NA | 14.78 | 13.53 | 12.94 |

1/ Estimated.

Table 2-25. Summary of Precipitation Measurements (inches) During the Past Five Years at Tract C-a.

| | 1978 | | | 1979 | | | 1980 | | | 1981 | | | 1982 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 |
| **Tipping Bucket Gauge** | | | | | | | | | | | | | | | |
| Winter | -- | -- | --. | 0.81 | 0.66 | 0.90 | 1.86 | 1.39 | 1.46 | 0.75 | 0.99 | -- | 1.02 | 0.98 | NA |
| Spring | -- | -- | 3.33 | 3.66 | 3.33 | 3.95 | 3.83 | 2.42 | 3.73 | 3.34 | 3.37 | 3.34 | 2.00 | 2.14 | |
| Summer | -- | 1.29[1/] | 1.58 | 2.38 | 2.23 | 1.71 | 2.65 | 2.58 | 3.52 | 4.29 | -- | -- | 2.55 | 2.40 | |
| Fall | 1.63 | 1.88 | -- | 2.93 | 2.02 | 2.15 | 0.98 | 1.77 | 1.61 | 4.87 | -- | 4.00 | -- | -- | |
| Annual | -- | -- | -- | 9.78 | 8.24 | 8.71 | 9.32 | 8.16 | 10.32 | 13.25 | -- | -- | -- | -- | |
| **Weighing Bucket Gauge** | | | | | | | | | | | | | | | |
| Winter | 4.15 | 3.90 | NA | 2.24 | 2.37 | NA | 2.27 | 2.51 | NA | 1.92 | 1.75 | NA | 2.59 | 2.47 | NA |
| Spring | 5.15 | 5.19 | | 6.06 | 4.78 | | 5.25 | 4.96 | | 3.61 | 4.68 | | 3.05 | 2.76 | |
| Summer | 1.71[1/] | 1.14[1/] | | 2.17 | 2.58 | | 2.56 | 2.94 | | 4.69 | -- | | 3.08 | 2.32 | |
| Fall | 3.21 | 2.21[1/] | | 3.28 | 3.09 | | 1.52 | 2.03 | | 6.59 | -- | | 7.64 | 7.23 | |
| Annual | 14.22 | 12.44 | | 13.75 | 12.81 | | 11.60 | 12.44 | | 16.81 | -- | | 16.36 | 14.78 | |
| **Wedge Gauge** | | | | | | | | | | | | | | | |
| Winter | 3.28 | 2.44 | 2.29 | 1.50 | 2.09 | 1.76 | 2.52 | 2.04 | 1.83 | 1.85 | 1.49 | 1.44 | 2.24 | 1.83 | 1.63 |
| Spring | 4.27 | 4.63 | 3.98 | 5.44 | 4.59 | 4.16 | 4.99 | 5.01 | 4.96 | 4.91 | 4.02 | 4.14 | 3.01 | 2.47 | 2.77 |
| Summer | 1.82 | 1.21 | 1.57 | 2.28 | 2.58 | 1.95 | 3.25 | 2.89 | 3.43 | 5.14 | 4.71 | 6.09 | 3.23 | 2.60 | 2.63 |
| Fall | 2.94 | 2.32 | 2.43 | 2.15 | 2.45 | 2.38 | 2.24 | 2.00 | 6.44 | 5.73 | 3.91 | 3.91 | 7.80 | 6.63 | 5.91 |
| Annual | 12.31 | 10.98 | 10.16 | 11.65 | 11.41 | 10.32 | 13.14 | 12.18 | 12.22 | 18.34 | 15.95 | 15.58 | 16.28 | 13.53 | 12.94 |

1/ Estimated.

Table 2-26. Number of Days with Precipitaion and Largest Precipitation Event (inches) for Each Month at Sites 1, 2, and 3, Tract C-a.

| Month | Site 1 | | Site 2 | | Site 3 | |
|---|---|---|---|---|---|---|
| | No. of Days With Precip. | Largest Event (Length in Days) | No. of Days. With Precip. | Largest Event (Length in Days) | No. of Days With Precip. | Largest Event (Length in Days) |
| January | 10 | 0.34(1) | 10 | 0.32(1) | 10 | 0.29(1) |
| February | 4 | 0.09(1) | 4 | 0.29(2) | 4 | 0.17(2) |
| March | 10 | 0.47(5) | 10 | 0.38(5) | 10 | 0.33(2) |
| April | 7 | 0.25(2) | 6 | 0.18(1) | 4 | 0.17(2) |
| May | 12 | 0.83(5) | 12 | 0.74(5) | 12 | 1.05(5) |
| June | 4 | 0.11(3) | 3 | 0.18(4) | 7 | 0.10(2) |
| July | 12 | 0.64(6) | 11 | 0.23(6) | 10 | 0.98(6) |
| August | 17 | 0.91(3) | 17 | 0.73(3) | 17 | 0.47(1) |
| September | 17 | 2.33(6) | 17 | 2.29(6) | 17 | 2.14(6) |
| October | 11 | 0.65(3) | 11 | 0.83(3) | 10 | 0.61(3) |
| November | 10 | 0.48(4) | 8 | 0.48(2) | 8 | 0.33(2) |
| December | 6 | 0.43(2) | 6 | 0.33(2) | 6 | 0.30(1) |

strongly negatively correlated with the spring precipitation (r=-0.79). Similar results were found with the Site 1 wedge gauge data, except that the correlation with summer precipitation was higher and the correlation with spring precipitation was not as strongly negative. Although these results are interesting, the relatively short period of record precludes putting a great deal of confidence in the results.

## E. Solar Radiation

### 1. Objective

Solar radiation is monitored to supplement the data base for interpreting the meteorological and air quality data.

### 2. Methods

The methods followed for collection of these data were described in MDP Monitoring Report 4 (RBOSC 1979a).

### 3. Results and Discussion

Table 2-27 presents the maximum and mean (based on daylight hours only) monthly solar radiation at Site 1 for the current year. Due to lightning damage in September, several months of data were lost. The mean monthly solar radiation values peaked during the month of the summer solstice (June) at 0.65 ly/min. This is very comparable to the 0.67 ly/min recorded in June of 1981.

Table 2-27. Maximum and Mean Solar Radiation (ly/min) at Site 1, January-December 1982, RBOSC Tract C-a

| Month | Maximum[1/] Solar Radiation (ly/min) | Mean[1/] Solar Radiation (ly/min) |
|---|---|---|
| January | 0.77 | 0.34 |
| February | 0.99 | 0.45 |
| March | 1.18 | 0.47 |
| April | 1.34 | 0.61 |
| May | 1.46 | 0.58 |
| June | 1.45 | 0.65 |
| July | 1.43 | 0.63 |
| August | 1.04 | 0.42 |
| September | -- | -- |
| October | -- | -- |
| November | -- | -- |
| December | -- | -- |
| Season | | |
| Winter | -- | -- |
| Spring | 1.46 | 0.55 |
| Summer | 1.45 | 0.57 |
| Fall | -- | -- |
| Annual | 1.46 | -- |

1/ Maximum and mean values computed from hourly average.

## 2.3 CLIMATOLOGY

This section presents a description of the general climatology of the region in which Tract C-a is located.

### 1. Objectives

It is the intent to develop a climatology by comparing meteorological data collected from the three RBOSC sites (defined as "onsite") with both short-term and long-term climatic data available from other meteorological stations in the region. The rugged topography of western Colorado causes variations in climate within short distances, and caution must be used when applying climatic generalizations to the whole area. Ideally, the most accurate way of characterizing the climatology of Tract C-a is to develop a long-term meteorological data base from data gathered onsite. The available onsite meteorological data base of seven years cannot be construed as being representative of the long-term climatic conditions in the tract area; however, the onsite data can be compared with similar short-term and long-term data in the region to identify site-specific climatic conditions due to elevation, exposure, and the orientation of mountain ranges and valleys.

### 2. Methods

The methods followed for collection of climatological data were described in MDP Monitoring Report 3 (RBOSC 1979).

### 3. Results and Discussion

Figure 2-13 presents the sources of climatological data in the northwest section of the State of Colorado, where Tract C-a is located at an average elevation of 7000 feet above MSL. The weather station closest to the tract is Little Hills, located 15 miles to the northeast at an elevation of 6140 feet. The Meeker No. 2 station is located about 30 miles to the east-northeast at an elevation of 6350 feet. The Rangely station is

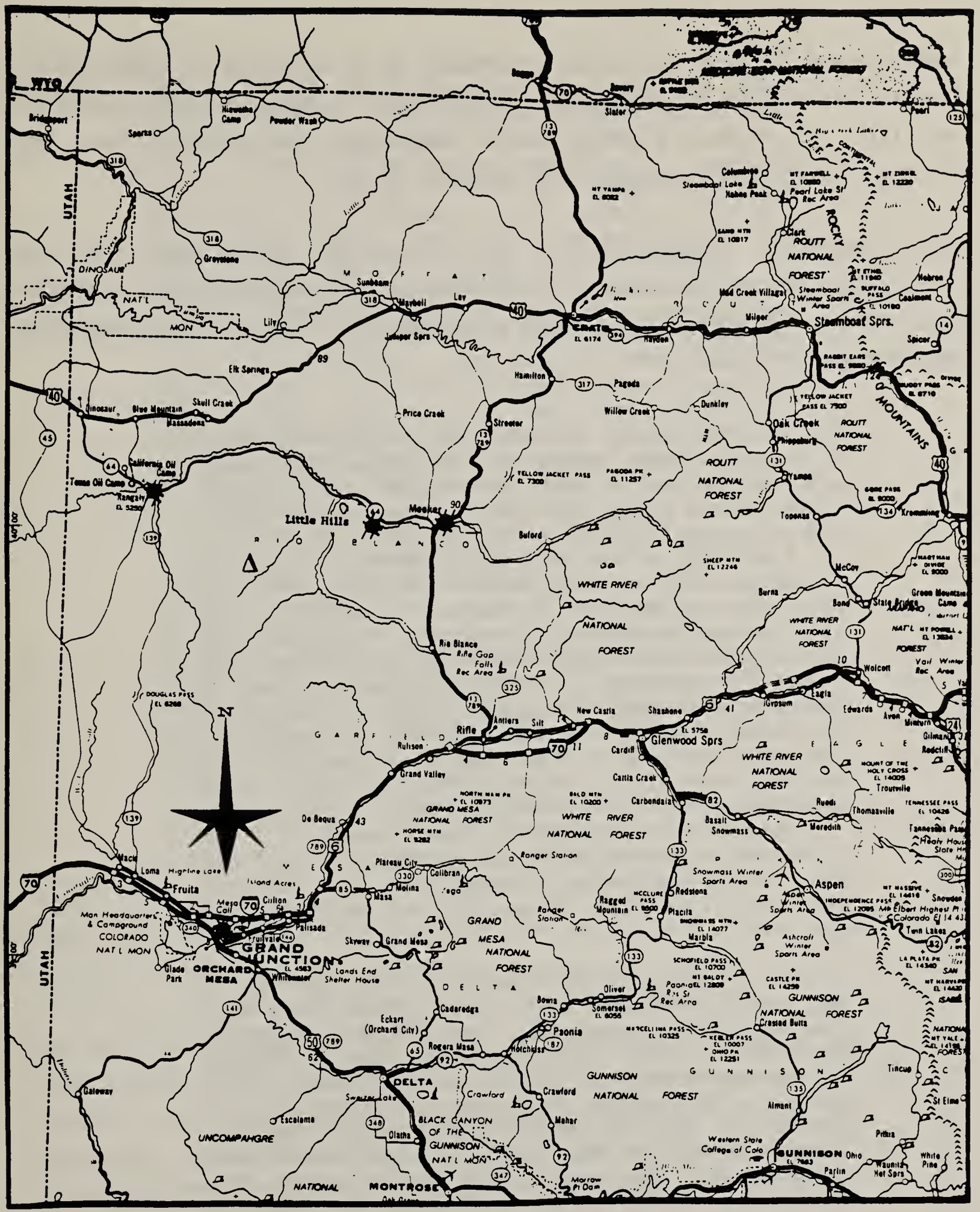



Figure 2-13. Map of Northwest Colorado Showing the Rio Blanco Region

located about 20 miles to the west-northwest at an elevation of 5220 feet. Grand Junction, at an elevation of 4843 feet, is about 60 miles south of the site. All of these stations monitor temperature and precipitation. At Grand Junction other parameters are measured as well.

The following is a discussion of the climatology of the area and the influences of the topography on the general meteorological and climatic conditions in the area. It has been extracted from the Final Environmental Baseline Report (RBOSP 1977):

> The Tract C-a area is surrounded by high mountains. As a result, many migratory low pressure systems are deflected around the region. Stationary high-pressure cells often persist for several days, their passage blocked by the Continent Divide east of Tract C-a. As a result, there is a high frequency of clear sunny days with light winds and large diurnal temperature changes. Gradient winds are generally westerly, existing throughout the year, except when interrupted by the passage of frontal systems. Precipitation measurements indicate relatively low annual accumulations such as those of semi-arid steppe regions. In addition, the data indicate a high degree of temporal and spatial variability in this area, which is to be expected given the rough terrain with its variations in elevation and exposure. The infrequent occurrences of precipitation , fog, and small light-scattering airborne dust have produced excellent visibility, in general, for the Tract C-a area.
>
> Local topography within the Tract C-a area has a much more pronounced effect on surface flows than the macroscale processes. Specific air movements produced by local conditions are often different from those expected from the major gradient flow. There is a tendency for wind velocities to be lowest at sunrise, when there is little vertical thermal mixing and the lower surface air does not couple with the more freely moving upper air. Conversely, velocities of local winds are greatest in the early afternoon hours when the air exhibits its greatest tendency to move vertically due to terrestrial heating, and couples with the faster air moving above it.

In the absence of strong gradient winds, the local terrain produces special meteorological conditions. During warm afternoon hours, the laterally constricted, but vertically expanding, air tends to flow up the valley. This air motion probably develops simultaneously with anabatic (upslope) winds which result from a greater heating of the valley sides than the valley floor. At night, the reverse process occurs with the cold, dense air at higher elevations draining into the depressions. The greater radiative heat loss affecting the higher elevations (especially if they are snow-covered) cools the air immediately adjacent to the surface, and this air sinks into the valley. Downward flowing cold air set in motion by this effect forms downslope winds leading to an accumulation of cold, dense, stable air in the valley bottom.

The high Cathedral Bluffs to the west of Tract C-a and the deep gulches to the east effectively channel surface winds, and thereby decouple the upper level flows from the surface flows much of the time. Several studies have shown that airflow within the canyons of the Piceance Creek and Yellow Creek Basins is influenced by drainage winds in their respective channels, whereas winds measured atop the ridge-like portions of the basin closely follow the gradient wind regime. It can be inferred that these drainage winds occur in conjunction with stronger temperature inversions within the valley than at the ridge regions.

Meteorological data collected at the site during the current year can be compared to data for the same period from Grand Junction and to the Grand Junction long-term averaged for the period 1941-1970. Table 2-28 presents the monthly departures from normal for Grand Junction mean temperature, total precipitation, mean relative humidity, and mean wind speed during the current year. The departure during the current year of the mean annual temperature at Grand Junction from the long term average was +0.7 F. The Grand Junction mean annual temperature exceeded the RBOSC Site 1 mean during the current year by 10.3 F. The annual precipitation during the current year at Grand Junction was 0.19 inches below the long-term average,

Table 2-28. Monthly Departures from the Long-Term Means for the Data Period January-December 1982 for Grand Junction and Comparison with Tract C-a Annual Values.

| | | Temperature (F) | | | Precipitation (inches) | | | Mean Wind Speed (mph) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month | Long Term Mean | 1982 Mean | Departure From Mean | Long Term Mean | 1982 Mean | Departure From Mean | Long Term Mean | 1982 Mean | Departure From Mean |
| Grand Junction | January | 26.6 | 26.0 | -0.6 | 0.64 | 0.29 | -0.35 | 5.6 | 7.6 | +2.0 |
| | February | 33.6 | 34.7 | +1.1 | 0.61 | 0.41 | -0.20 | 6.7 | 6.8 | +0.1 |
| | March | 41.2 | 46.0 | +4.8 | 0.75 | 0.79 | +0.04 | 8.4 | 9.7 | +1.3 |
| | April | 51.7 | 51.3 | -0.4 | 0.79 | 0.09 | -0.70 | 9.7 | 11.2 | +1.5 |
| | May | 62.2 | 61.4 | -0.8 | 0.63 | 0.75 | +0.12 | 9.6 | 10.1 | +0.5 |
| | June | 71.3 | 72.2 | +0.9 | 0.55 | 0.21 | -0.34 | 9.8 | 11.6 | +1.8 |
| | July | 78.7 | 79.0 | +0.3 | 0.46 | 0.35 | -0.11 | 9.3 | 9.3 | 0.0 |
| | August | 75.4 | 78.2 | +2.8 | 1.05 | 0.94 | -0.11 | 9.0 | 8.7 | -0.3 |
| | September | 67.2 | 67.5 | +0.3 | 0.84 | 2.81 | +1.97 | 9.0 | 9.4 | +0.4 |
| | October | 54.9 | 51.9 | -3.0 | 0.93 | 0.83 | -0.10 | 7.9 | 8.1 | +0.2 |
| | November | 39.8 | 41.2 | +1.4 | 0.61 | 0.48 | -0.13 | 6.6 | 7.3 | +0.7 |
| | December | 29.5 | 33.0 | +3.5 | 0.55 | 0.27 | -0.28 | 5.9 | 6.8 | +0.9 |
| | Annual | 52.7 | 53.5 | +0.7 | 8.41 | 8.22 | -0.19 | 8.1 | 8.9 | +0.8 |
| RBOSC Site 1 | | NA | 43.2 | NA | NA | 16.36 | NA | NA | 6.9 | NA |
| RBOSC departure from Grand Junction | | NA | -10.3 | NA | NA | +8.33 | NA | NA | -2.0 | NA |
| RBOSC Site 1 7-yr Mean[1/] | | 44.6 | | | 14.55[2/] | | | 7.0 | | |

1/ The 7-year mean data does not constitute a long term mean.
2/ Based on a 5-year data record.

but 8.33 inches below the total measured at Site 1 for the year. The Site 1 mean wind speed was 2.0 mph lower than the Grand Junction mean wind speed for the current year.

Table 2-28 indicates that Grand Junction data compares rather poorly with onsite data. There has been a consistent decrease in mean annual temperature of 7-10 F from Grand Junction to Tract C-a during the last five years. In addition, there has been an increase in annual precipitation from Grand Junction to Tract C-a in each of the last five years, although the increases in 1981 and 1982 of approximately 8 inches have been the largest. Consequently, Grand Junction data should be used very cautiously in describing the climatology of the region. This climatic difference between Site 1 and Grand Junction can also be seen in the frost-free period (Table 2-16), which was 26 days longer during 1981 at Grand Junction.

This difference is not unexpected, since Grand Junction is located in a valley approximately 2500 feet lower than Site 1. In fact, by using the NACA Standard Atmosphere lapse rate for 40$^{o}$N latitude of 3.57 F/1000 ft (Hess 1959), an estimate can be made of the temperature that would be expected if the Grand Junction station was at the same altitude as Site 1. Using this approximation, the Grand Junction mean annual temperature would be reduced by 8.9 F. Thus, the large discrepancy in mean annual temperatures between the site and Grand Junction can be accounted for simply by the altitude differential.

Table 2-29 presents monthly temperature data collected during the current year from Site 1, three surrounding climatological stations (Rangely, Meeker No. 2, and Little Hills), and Grand Junction. The table shows that Grand Junction temperature data are not very representative of Rio Blanco County. The mean monthly and annual temperatures at the three climatological stations in the county agree well with the onsite data, especially considering the elevation and topographical differences among the sites. However, a major difference between Site 1 and the other stations is evident in the temperature range (the difference between the maximum and the minimum), which is greater at the climatological stations.

Table 2-29. Comparison of Monthly Temperatures (F) in the Vicinity of Tract C-a for the Data Period January-December 1982.

| | Tract C-a Site 1 | | | Little Hills | | | Meeker No. 2 | | | Rangely | | | Grand Junction | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Avg Max | Avg Min | Mean | Avg Max | Avg Min | Mean | Avg Max | Avg Min | Mean | Avg Max | Avg Min | Mean | Avg Max | Avg Min | Mean |
| January | 30.2 | 18.0 | 24.1 | 31.4 | 0.1 | 15.8 | 37.7 | 10.5 | 24.1 | 34.2 | 1.1 | 17.7 | 35.4 | 16.5 | 26.0 |
| February | 32.0 | 19.2 | 25.9 | 35.8 | 3.1 | 19.5 | 41.6 | 11.3 | 26.5 | 41.6 | 10.8 | 26.2 | 44.8 | 24.6 | 34.7 |
| March | 39.2 | 27.0 | 33.1 | 43.9 | 17.3 | 30.6 | 48.9 | 23.5 | 36.2 | 53.6 | 23.8 | 38.7 | 57.1 | 34.9 | 46.0 |
| April | 46.4 | 28.9 | 38.5 | 51.0 | 17.1 | 34.1 | 56.7 | 24.1 | 40.4 | 62.4 | 27.1 | 44.8 | 65.1 | 37.5 | 51.3 |
| May | 56.1 | 41.2 | 48.7 | 61.1 | 28.7 | 44.9 | 65.2 | 35.5 | 50.5 | 71.4 | 38.1 | 54.8 | 74.7 | 48.0 | 61.4 |
| June | 68.0 | 50.0 | 59.5 | 76.5 | 35.7 | 56.1 | 76.0 | 40.7 | 58.4 | | M | | 87.2 | 57.2 | 72.2 |
| July | 75.2 | 59.0 | 67.3 | 83.6 | 43.3 | 63.5 | 83.9 | 49.1 | 66.5 | 90.9 | 55.9 | 73.4 | 93.5 | 64.4 | 79.0 |
| August | 74.7 | 59.5 | 66.9 | 83.2 | 47.2 | 65.2 | 83.1 | 52.0 | 67.6 | 89.8 | 56.6 | 73.2 | 90.4 | 65.9 | 78.2 |
| September | 63.5 | 50.4 | 57.6 | | M | | 70.7 | 42.8 | 56.8 | 77.5 | 45.7 | 61.6 | 78.6 | 56.3 | 67.5 |
| October | 48.6 | 34.2 | 41.5 | | M | | 58.9 | 28.0 | 43.5 | | M | | 63.5 | 40.3 | 51.9 |
| November | 36.7 | 25.3 | 30.7 | | M | | 44.6 | 18.3 | 31.5 | 45.1 | 21.6 | 33.4 | 50.2 | 32.2 | 41.2 |
| December | 28.9 | 18.9 | 23.9 | | M | | 36.7 | 14.0 | 25.4 | 34.6 | 11.4 | 23.0 | 41.8 | 24.2 | 33.0 |
| Annual | | | 43.1 | | | | | | 44.0 | | | | | | 53.5 |

M = Missing data.

This is due primarily to the relative height of the instruments above the ground surface. Climatological stations measure temperature 6 feet above the ground in a standard weather shelter, whereas the Site 1 temperature sensor is located at 10 meters (33 ft.). Since temperature changes in the lower layers of the atmosphere result from heat transfer to and from the ground surface, the diurnal temperature range will decrease with height above the ground. Thus, the reduced temperature range at Site 1 relative to the surrounding stations is largely due to the increased height of the temperature sensors at Site 1.

Table 2-30 presents a comparison of precipitation data from Site 1 and from surrounding stations for the current year. Monthly precipitation amounts at all of the stations vary widely due to the complex orographic influences of the region and the intermittent nature of precipitation (particularly during the summer), but annual totals between Site 1 and the climatological stations are reasonably close, ranging between 14 and 16 inches. Grand Junction, with only 8 inches of precipitation, had the lowest monthly total of all stations, probably because of its location in a large valley.

Table 2-30. Comparison of Monthly Precipitation (inches) in the Vicinity of Tract C-a for the Data Period January-December 1982.

| Month | Tract C-a Site 1 | Little Hills | Meeker No. 2 | Rangely | Grand Junction |
|---|---|---|---|---|---|
| January | 1.18 | 0.76 | 0.79 | 0.63 | 0.29 |
| February | 0.45 | 0.48 | 0.29 | 0.16 | 0.41 |
| March | 0.91 | 0.88 | 0.61 | 1.08 | 0.79 |
| April | 0.70 | 0.43 | 0.62 | 0.32 | 0.09 |
| May | 1.44 | 2.16 | 1.82 | 1.26 | 0.75 |
| June | 0.11 | 0.39 | 0.03 | 0.21 1/ | 0.21 |
| July | 0.92 | 0.85 | 1.29 | 2.04 | 0.35 |
| August | 2.05 | 1.22 | 2.42 | 1.28 | 0.94 |
| September | 4.33 | 3.81 | 3.40 | 4.18 | 2.81 |
| October | 2.10 | 1.64 | 1.57 | 1.66 | 0.83 |
| November | 1.21 | 1.13 | 0.62 | 0.76 | 0.48 |
| December | 0.96 | 0.84 | 0.63 | 0.50 | 0.27 |
| Annual | 16.36 | 14.59 | 14.09 | 14.08 | 8.22 |

1/ Average of June precipitation for Little Hills and Meeker No. 2 stations.

## 2.4 QUALITY ASSURANCE AND DATA RECOVERY

The data upon which this report is based, with the exception of the visibility, precipitation and total suspended particulate data, were collected by an automatic data acquisition system located on Tract C-a. The data are recorded on magnetic tape, paper printouts and analog strip chart recorders. A comprehensive quality assurance program has been maintained to ensure the reliability and accuracy of the data. This program includes documentation by the site technician of all calibrations and system malfunctions, weekly zero and span calibrations of the air quality instrumentation, utilization of control charts onsite to detect problems in the weekly span calibrations, quarterly calibrations of the air quality instrumentation by both the RBOSC technical staff and an independent auditing team, semiannual calibrations of the meteorological instrumentation, and review of the analog and digital data by qualified analysts.

The air quality instruments are calibrated with reference gases traceable to National Bureau of Standards (NBS) standards. The carbon monoxide, sulfur dioxide, hydrogen sulfide, and nitrogen oxide analyzers were calibrated using known concentrations of test gases which had been certified by the vendor. The ozone analyzer is calibrated using a U.V. photometer.

Each instrument was tested at least once a week by inserting a zero pollutant concentration and at least one upscale concentration. These tests provided data on instrument drift and ensured that the instrument would respond to a detectable level of pollutant concentration in the ambient air.

The quarterly field calibrations were used to determine the accuracy of the instruments. Independent quarterly audits by a contractor (Northrop, Inc.) were used to check the field calibrations.

The air quality data include many values representing hours when the concentration of some pollutants fell below the reliable threshold of detection of the instrument (based on the manufacturer's specifications). When this occurred, a number equal to one-half the threshold value was substituted for the data point. This procedure is adopted from the EPA Quality Assurance Handbook, Air Pollution Measurement, Vol. 1. This applied to sulfur dioxide, hydrogen sulfide, nitrogen oxides, and carbon monoxide data acquired through much of the data period.

The meteorological system is calibrated on a semiannual basis. This includes routine replacement of all wind speed and wind direction sensors. No correction factors were required to adjust the data.

Data recoveries for all meteorological and air quality parameters collected by the onsite data acquisition system are presented in Tables 2-31 and 2-32. The data recovery of each meteorological or air quality parameter was at least 94 percent, with the exception of the dewpoint and solar radiation at Site 1. The data loss for these two parameters was primarily due to a direct lightning strike at Site 1 in September. Both instruments were severely damaged and had to be returned to the manufacturers for repair and calibration.

Table 2-31. Annual Data Recovery (%) of Air Quality Parameters Monitored at Tract C-a for the Period January-December 1982.

| Parameter | Data Recovery (%) |
|---|---|
| Site 1 | |
| $SO_2$ | 97 |
| $H_2S$ | 97 |
| NO | 96 |
| $NO_x$ | 96 |
| $O_3$ | 98 |
| CO | 98 |

Table 2-32. Annual data Recovery (%) of Meteorological Parameters Monitored at Tract C-a for the Period January-December 1982.

| Parameter | Data Recovery (%) |
|---|---|
| Site 1 | |
| 10 m wind speed | 96 |
| 10 m wind direction | 96 |
| 60 m wind speed | 96 |
| 60 m wind direction | 96 |
| 10 m temperature | 96 |
| 60 m temperature | 96 |
| Delta T 60-10 m | 94 |
| Dew point | 43 |
| Solar radiation | 68 |
| Site 1 | |
| 10 m wind speed | 96 |
| 10 m wind direction | 96 |
| 10 m temperature | 97 |

## 2.5 VISIBILITY

Documentation of visibility in the Piceance Creek Basin is a cooperative study conducted by RBOSC and the Cathedral Bluffs Oil Shale Company.

### 1. Objectives

The objectives of this program are to document the visibility in the area of the Piceance Creek Basin and identify trends or variations in visibility which may be evident during the monitoring program. The results of this program will provide visibility data against which future data may be compared, and with which concurrent meteorological and air quality data may be incorporated for further evaluation and consideration.

### 2. Methods

Two methods are being employed to measure basin-wide visibility during the spring and fall studies. A photographic photometry method incorporates techniques identical to those utilized during the baseline study to calculate visual ranges; these techniques were described in MDP Monitoring Report 1 (RBOSC 1978). A second method uses a telephotometer to derive visual ranges. Data are normally collected every fourth day from a centrally located shelter (Figure 2-14) during the spring and the fall.

### 3. Results and Discussion

This analysis, similar to the earlier studies in 1975-76, 1978, 1979, 1980, and 1981, is based only on the photometry data. Comparisons between the two methods will be made after reduction of the telephotometer data has been completed, which is expected to be completed within six months.

During the 1982 monitoring period, visual range measurements were made on the 10 scheduled days during two months in the spring and 10 days during two months in the fall. The spring study was conducted in May and June, and the fall study was conducted in September and October. Of a possible

# Figure 2-14. Piceance Creek Basin Visibility Study Camera Site and Views

| VIEW: | I | | II | | III | | IV | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| OBJECT: | ⓪ | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ |
| DISTANCE: (MILES) | 29 | 54 | 24 | 42 | 10 | 37 | 17 | 26 | 46 | 56 |

0 5 10 15 Miles

ALLRED PEAK ① · LITTLE SNAKE R · YAMPA RIVER · ② · N · VIEW I · ③ WAPITI PEAK · VIEW II · 40 · 13 · DANFORTH HILLS ⑤ · MOFFAT COUNTY / ROUTT COUNTY · MOFFAT COUNTY / RIO BLANCO COUNTY · ROUTT COUNTY / RIO BLANCO COUNTY · WHITE RIVER ⓪ · 64 · 2-74 · YAMPA RIVER ② · VIEW III · MEEKER · 13 · 789 · 64 · NORTH FORK WHITE RIVER ⑨ · WHITE RIVER ⑧ · VIEW IV · ⑦ · YELLOW CREEK · CATHEDRAL BLUFFS · TRACT C-a · BLACK SULPHUR CREEK · PICEANCE CREEK · ④ · ⑥ · TRACT C-b · CAMERA · HUNTER CREEK · RIO BLANCO · RIO BLANCO COUNTY / GARFIELD COUNTY

560 scheduled visual range measurements during the two seasons, 516 valid measurements were obtained, for a 92 percent data recovery.

Measurements of visual range during the year were occasionally hampered by passing rain or snow showers which restricted visibility and made photography of the views difficult. Accumulations of snow on some objects being photographed required adjustments to be made in their albedo (short-wave reflectivity). The resulting albedo for these objects was estimated using the original albedo of the object modified by the relative contribution of the snow. The albedo values used for the original objects' surfaces and for the additional snow cover were based on the spectral reflectance of snow and various soil types listed in the Handbook of Geophysics and Space Environments (Valley 1975).

Visual range measurements have now been taken over five periods which can be compared: fall 1975 and spring 1976, which represent the baseline period; and the spring and fall of 1978, 1979, 1980, 1981, and 1982, which represent the MDP period.

a. Evaluation of visual range on a daily basis - The computation of a daily mean visual range provides an indication of the prevailing visibility found during the course of a day, with less emphasis on short-term or directional anomalies. Daily mean, maximum, and minimum visual ranges in the Piceance Creek Basin were calculated for each day of monitoring and the results are presented in Table 2-33.

The daily mean visual ranges obtained during 1982 were generally high and were most frequently between 70 and 80 miles, although they varied from 69 to 174 miles. The hourly visual ranges used to compute the daily mean visual ranges for the spring and fall monitoring periods are included in Appendices 2-4.1 and 2-4.3, respectively. Descriptions of visual and meteorological conditions existing on the sampling days are presented as Site Log Sheets in Appendices 2-4.2 and 2-4.4.

Table 2-33 Daily Mean Visual Range (Miles), Piceance Creek Basin, Colorado, Spring and Fall, 1982.

| | Date | Mean Visual Range | Hourly Min./Max |
|---|---|---|---|
| Spring | May 3 | 97 | 79/106 |
| | 7 | 174 | 162/193 |
| | 11 | 75 | 62/85 |
| | 19 | 86 | 56/104 |
| | 23 | 106 | 89/118 |
| | 27 | 108 | 92/119 |
| | June 4 | 116 | 102/132 |
| | 8 | 110 | 94/128 |
| | 12 | 118 | 99/136 |
| | 16 | 104 | 89/119 |
| Fall | September 4 | 81 | 55/107 |
| | 16 | 76 | 64/90 |
| | 20 | 70 | 60/86 |
| | 24 | 85 | 68/95 |
| | October 2 | 69 | 55/95 |
| | 6 | 77 | 70/85 |
| | 10 | 70 | 54/86 |
| | 14 | 79 | 66/90 |
| | 18 | 78 | 55/106 |
| | 22 | 73 | 54/94 |

The daily mean visual range is computed as an average of the visual ranges in each of four views (Figure 2-15). The increases or decreases in mean visual range between consecutive sampling days, evident in Table 2-33, were generally matched by similar increases or decreases in the visual range for each view. These fluctuations, shown in Figure 2-15, illustrate the similar response to changes in visibility which each view exhibited. The correlation between fluctuations in daily mean visual ranges among the views implies that the influences on visibility were widespread and generally uniform in the way they affected visibility.

b. Evaluation of visual range on a seasonal basis - Visual range measurements were made in May and June, and in September and October to quantify and characterize the visibility of the area. The selection of these seasons for data collection was based on the results of the initial study (1975-76), which indicated that the seasonal mean visual range was at a minimum during the spring and at a maximum during the fall. Visibility data measured during these two seasons in 1982 are compared with data obtained during the five earlier years of record.

The visual ranges obtained within the Piceance Creek Basin during the two seasons in 1982 were generally high; the mean visual ranges were 109 miles during the spring and 76 miles during the fall. These and additional statistical descriptors are listed in Table 2-34 for each season and for the comparable seasons in the previous years. The data for 1975-76, however, include three months per season.

The median is perhaps a better measure of the central tendency of a data set than the mean, since it is unbiased by extreme values. Table 2-34 shows that, over the years, the seasonal mean visual ranges have been close to the median visual ranges. During the baseline period, there was a much lower median visual range in the spring than in the fall (67 versus 92 miles). Although in general the average spring visibility has been lower than average fall visibility, this year just the opposite situation occurred - the median spring visibility was 108 miles and the fall visibility was 76 miles. This visual range of 108 miles in the spring of

SPRING SEASON 1982

FALL SEASON 1982

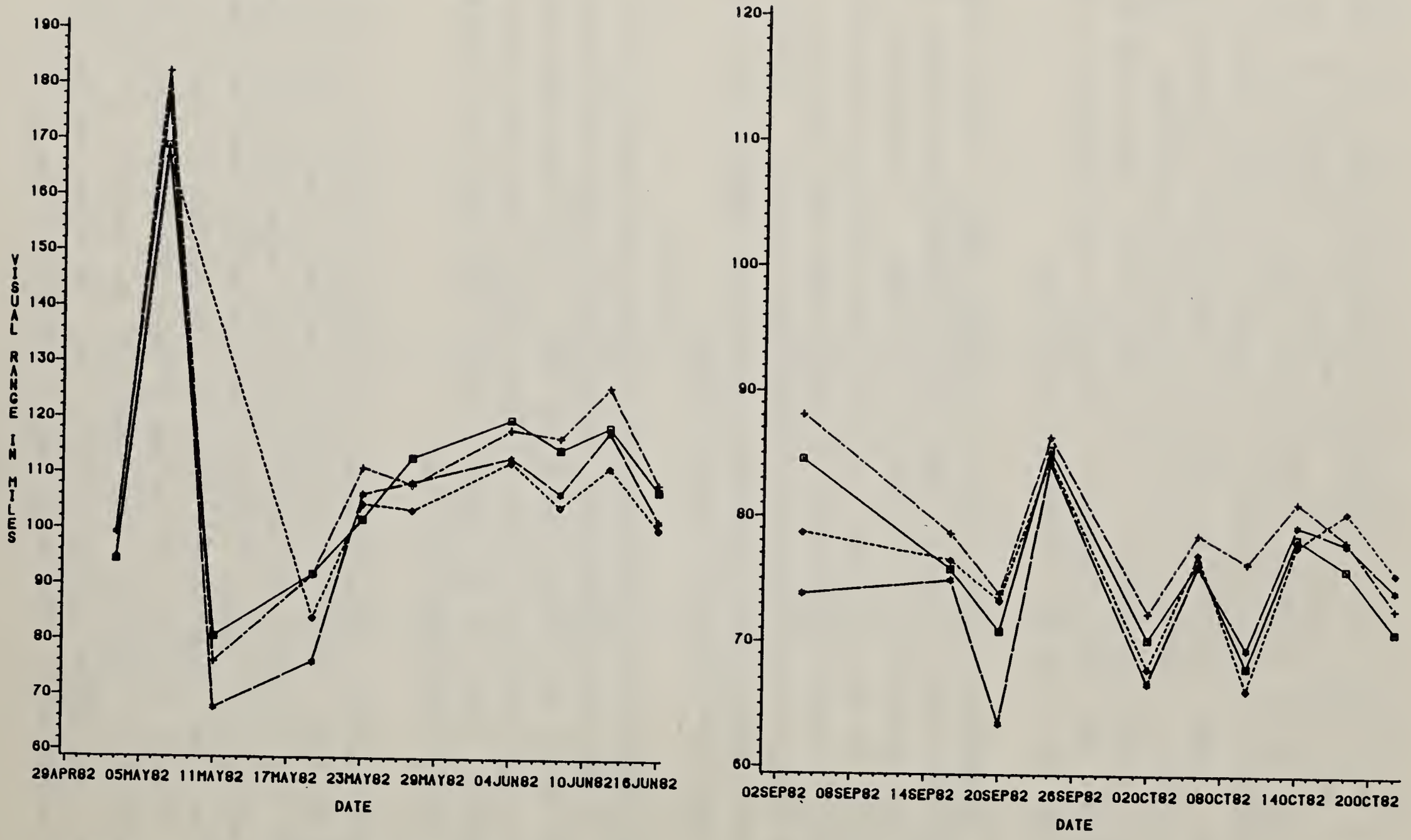



FIGURE 2–15. DAILY MEAN VISUAL RANGE FOR EACH VIEW, PICEANCE BASIN, 1982.

Table 2-34. Seasonal Composite Visual Range Comparison (Miles During Spring and Fall for 1975-1976, 1978, 1979, 1980, and 1981, Piceance Creek Basin, Colorado.

| Season | Mean | Maximum | Minimum | Fifth Percentile | Median |
|---|---|---|---|---|---|
| Spring 1982 | 109 | 193 | 56 | 76 | 108 |
| Spring 1981 | 84 | 160 | 37 | 46 | 83 |
| Spring 1980 | 78 | 126 | 22 | 45 | 78 |
| Spring 1979 | 77 | 154 | 36 | 46 | 72 |
| Spring 1978 | 79 | 142 | 17 | 43 | 81 |
| Spring 1975-76 | 69 | 138 | 14 | 39 | 69 |
| Fall 1982 | 76 | 107 | 54 | 57 | 76 |
| Fall 1981 | 87 | 175 | 33 | 55 | 83 |
| Fall 1980 | 93 | 176 | 17 | 55 | 90 |
| Fall 1979 | 84 | 137 | 36 | 42 | 87 |
| Fall 1978 | 80 | 130 | 22 | 43 | 82 |
| Fall 1975-76 | 91 | 149 | 24 | 45 | 92 |

1982 is the highest seasonal average recorded during the monitoring program. Rather than reflecting a major improvement in visibility, it was probably a result of the sampling days falling on a series of exceptionally clear days.

The seasonal composite visual range summary for the spring and fall for 1982 is shown in Figure 2-16. Similar figures were presented for 1981, 1980, and the 1975-76 baseline period in MDP Environmental Monitoring Report No. 9. There was a shift toward lower visual ranges in the fall during 1982 which, as discussed above, is contrary to the trend established in previous years.

Table 2-35 shows the seasonal visual range summary for each view during all seven years of record. The table shows that the mean visual range data for the spring of each year are relatively similar for each of the four views. During the fall, however, the data from all years except 1982 show a wider scatter of visual ranges among views within any particular year.

c. Evaluation of visual range on an annual basis - Visual range measurements made during 1982 were the highest collected during the period of record, with an annual mean visual range of 93 miles. This compares with an annual mean of 86 miles in 1981, 85 miles in 1980, 80 miles in 1979, and 79 miles during the first two years of study (Table 2-36). Both the maximum and minimum values collected during 1982 were higher than during previous years; visual ranges in 1982 varied from 54 miles to 193 miles. The distribution of these values is presented in Figure 2-17. Visual range distributions for 1981, 1980, and 1975-76 were presented in MDP Environmental Monitoring Report No. 9. Figure 2-17 shows that the most frequent visual range was 70-80 miles in 1982; this was also the case in 1980 and 1981. A higher frequency of visual ranges, those above 100 miles, distinguished the 1982 monitoring period. Most of the higher visual ranges in 1982 occurred during the spring.

This summary of the visibility data has shown that there has been a slight trend toward higher visual ranges since the original study was conducted in 1975-76. The spring of 1982 had an exceptionally high visual range, reversing the normal characteristic of higher visual ranges in the fall.

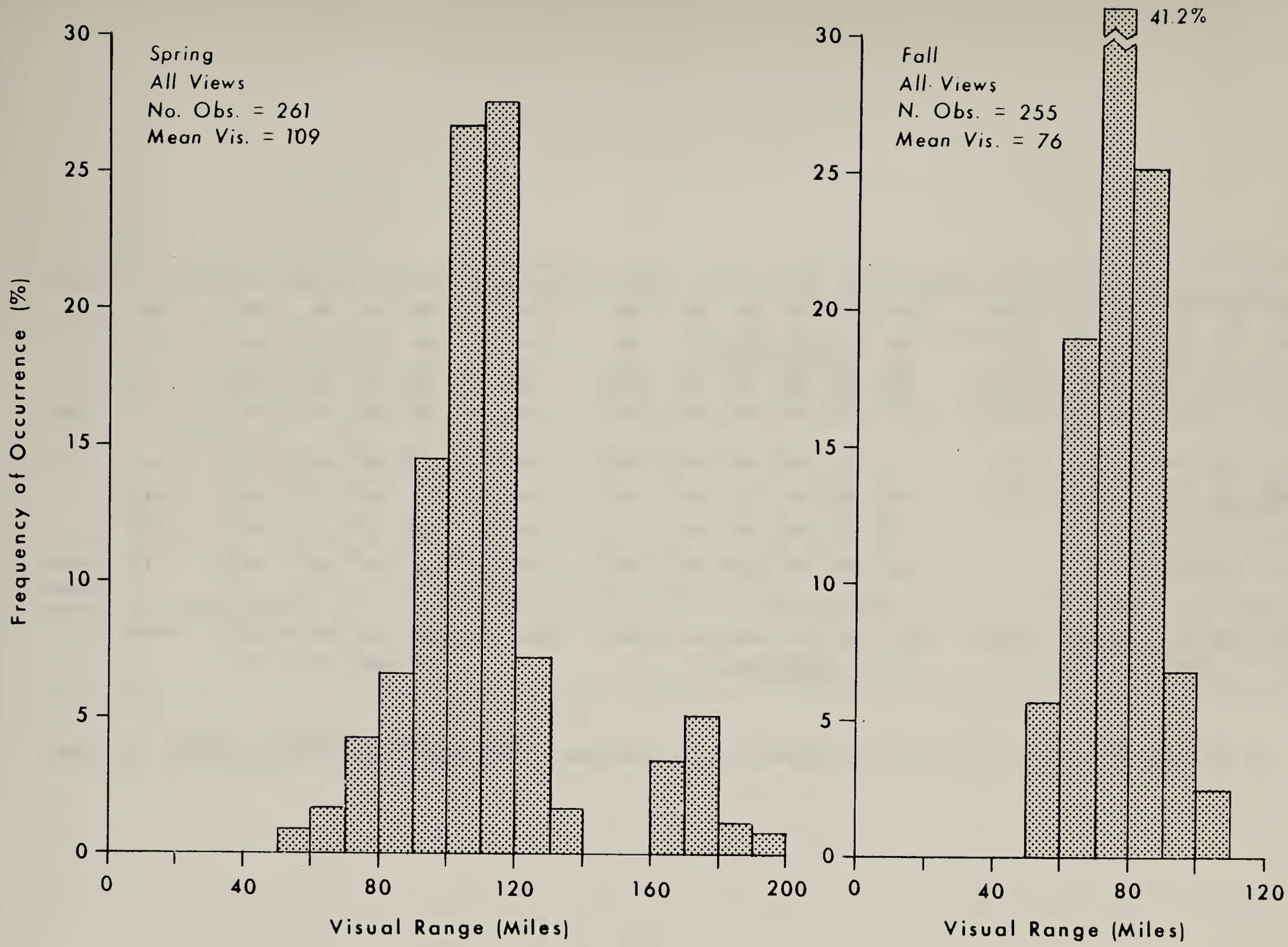



Figure 2-16. Seasonal Composite Distribution of Visual Range, Spring and Fall 1982, Piceance Creek Basin, Colorado.

Table 2-35. Seasonal Visual Range Summary (Miles) for Five Periods: Fall 1975 and Spring 1976, Spring and Fall of 1978, 1979, 1980, 1981, and 1982, in the Piceance Creek Basin, Colorado.

| | | Mean | | | | | | Hourly Maximum | | | | | | Hourly Minimum | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | View | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 |
| Spring | I | 74 | 81 | 81 | 80 | 90 | 111 | 118 | 126 | 139 | 126 | 160 | 174 | 39 | 51 | 36 | 29 | 44 | 73 |
| | II | 63 | 73 | 73 | 72 | 76 | 109 | 113 | 112 | 129 | 102 | 118 | 170 | 32 | 32 | 43 | 35 | 37 | 70 |
| | III | 67 | 77 | 82 | 76 | 81 | 107 | 118 | 132 | 154 | 119 | 149 | 193 | 14 | 17 | 44 | 22 | 38 | 56 |
| | IV | 73 | 84 | 74 | 85 | 87 | 114 | 138 | 142 | 141 | 120 | 138 | 193 | 27 | 35 | 39 | 37 | 45 | 63 |
| Fall | I | 93 | 87 | 84 | 92 | 88 | 76 | 149 | 130 | 126 | 161 | 151 | 103 | 37 | 58 | 41 | 45 | 53 | 54 |
| | II | 77 | 76 | 76 | 83 | 82 | 76 | 142 | 102 | 132 | 156 | 161 | 105 | 42 | 55 | 41 | 47 | 43 | 54 |
| | III | 92 | 71 | 82 | 88 | 87 | 74 | 146 | 103 | 128 | 138 | 150 | 106 | 24 | 22 | 25 | 17 | 33 | 54 |
| | IV | 101 | 86 | 94 | 111 | 92 | 79 | 148 | 125 | 137 | 176 | 175 | 107 | 48 | 31 | 36 | 56 | 35 | 57 |

Table 2-36. Annual Visual Range Summary (Miles) for Six Periods: 1975-76, 1978, 1979, 1980, 1981, and 1982, in the Piceance Creek Basin, Colorado.

| View | Mean | | | | | | Hourly Maximum | | | | | | Hourly Minimum | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 | 1975-76 | 1978 | 1979 | 1980 | 1981 | 1982 |
| I | 83 | 83 | 83 | 85 | 89 | 93 | 149 | 130 | 139 | 161 | 160 | 174 | 31 | 51 | 36 | 29 | 44 | 54 |
| II | 69 | 74 | 74 | 77 | 79 | 92 | 142 | 112 | 132 | 156 | 161 | 170 | 31 | 32 | 41 | 35 | 37 | 54 |
| III | 78 | 74 | 82 | 82 | 84 | 91 | 149 | 132 | 154 | 138 | 150 | 183 | 14 | 17 | 25 | 17 | 33 | 54 |
| IV | 85 | 85 | 83 | 97 | 90 | 96 | 148 | 142 | 141 | 176 | 175 | 193 | 22 | 31 | 39 | 37 | 35 | 57 |
| Composite | 79 | 79 | 80 | 85 | 86 | 93 | 149 | 142 | 154 | 176 | 175 | 193 | 14 | 17 | 25 | 17 | 33 | 54 |

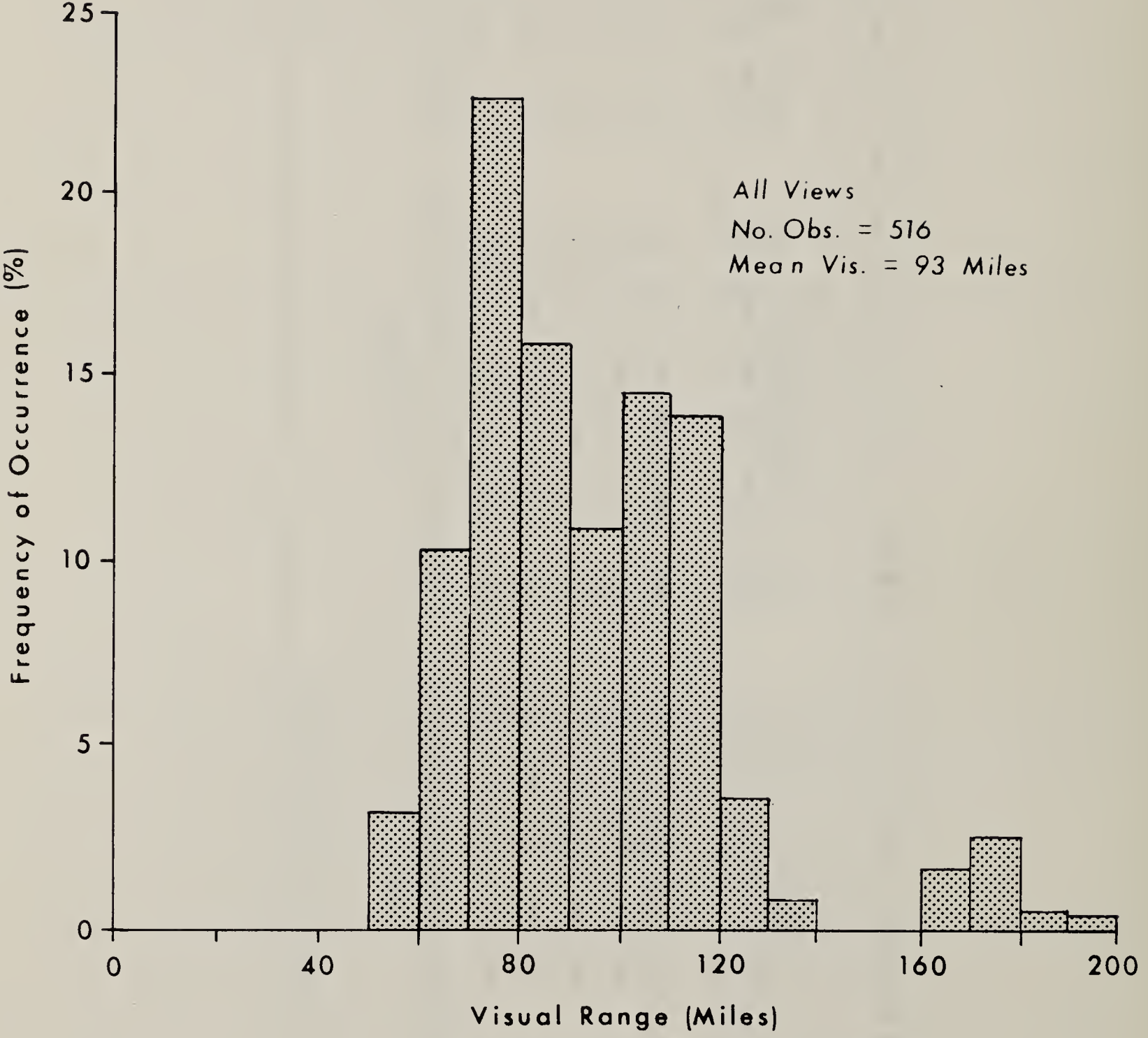



Figure 2-17. Annual Composite Distribution of Visual Range, 1982, Piceance Creek Basin, Colorado

## 2.6 NOISE

Development activities on Tract C-a will result in increased noise levels in the area. In order to assess the potential effects of these increased noise levels, it will be necessary to identify the sources of the noise and the intensity of noise levels at various distances from these sources. The noise survey is designed to provide these data.

### 1. Objectives

Regulations regarding allowable noise levels have been promulgated for the safety and well-being of humans. None of the existing regulations apply to effects of noise on wildlife, although some research has been conducted in this area (EPA 1971). The following are the objectives of the environmental noise program:

- Provide a data base on relative noise levels at various distances from sources on the tract.
- Provide data for use by wildlife biologists in assessing the overall impacts of tract development on wildlife behavior and use of the study area.

### 2. Methods

In order to acquire the necessary noise level measurements, sound level readings are taken once each quarter at strategic monitoring sites around the tract development area. During the period of study, four noise surveys were made with a General Radio Model 1565-D sound level meter, which has a threshold of 30 dBA. Noise measurements were taken at 16 monitoring sites on February 15, May 14, August 16, and November 16, 1982.

The noise monitoring sites are arranged in a configuration of concentric circles at various distances from the area of activity out to the borders of Tract C-a, as described in Table 2-37. One other reading was taken in

Table 2-37. Locations of Environmental Noise Monitoring Sites, Tract C-a

| Site Number | Locations/Descriptions |
|---|---|
| 1 | Top of knoll N.E. of Hunting Camp, E. of road down to Corral Gulch |
| 2 | South side of site access road, 20 ft S.W. of "Hill" signs |
| 3 | N.E. corner of intersection of Airplane Ridge Road and tank access road |
| 4 | South side of Corral Gulch Road at fence corner slightly past power line |
| 5 | 100 ft. S.E. from well CE-707, on line between survey point and headframe |
| 6 | Northwest of Well TO-2 outside of fence, 10 ft W. of survey point |
| 7 | North side of Corral Gulch Road at Well G-S 4-5 on top of road cut |
| 8 | West side of Wolf Ridge road on small knoll directly across from entrance to Well G-S 6 and trailer camp |
| 9 | North side of fenced area at Well TO-1 near entrance |
| 10 | South side of Box Elder Gulch Road at N.E. fence corner for Well AM-3 |
| 11 | North side of Corral Gulch Road at turn-around area, across from U.S.G.S. stream gauging station |
| 12 | South side of road to Met. Site #1, 0.1 mile from power line crossing and S.W. corner of well G-S 1 |
| 13 | North side of Wolf Ridge Road, N.E. corner of road to Well G-S 10 |
| 14 | South side of Wolf Ridge Road at Tract C-a boundary line |
| 15 | East side of road, 0.15 mile north of Met. Site #2 access road |
| 16 | North of County Road 24 at intersection of Wolf Ridge Road |
| A | Approximately 30 ft east of main shaft headframe |

close proximity to the headframe at the main process area for an indication of highest noise levels.

The methods followed in the collection of noise data were described in MDP Monitoring Report 3 (RBOSC 1979).

## 3. Results and Discussion

Sound level readings taken during the four surveys are shown in Tables 2-38 through 2-41. The highest average decibel levels ranged from 57 dBA in the high November survey to 64 dBA in the May and August surveys. All of these high readings were obtained at the monitoring site near the headframe, which is the focal point of onsite activity. Most of the measured noise levels were below the instrument detection level (30 dBA). Background noise levels were reached when readings were taken at distances greater than about one mile from the MIS process site. Exceptions to background noise were noted when there were aircraft passing overhead, vehicular traffic, or some other activity, such as an oil drilling rig operating near the monitoring site.

Noise levels taken during these four surveys were somewhat lower than earlier surveys, reflecting lower activity levels on Tract C-a. The potential for wildlife disturbances due to noise of this magnitude is anticipated to be small.

Table 2-38. Environmental Sound Level Measurements Tract C-a, February 15, 1982

| Site | Time | Wind | Sound Level Measurements (dBA, Slow Response) (20 sec range) 1 | 2 | 3 | 4 | 5 | Sound Level Range (dBA) | Sound Level Average (dBA) [1/] | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 1003 | 0-2 W | 60-62 | 60-61 | 59-61 | 59-62 | 69-61 | 59-62 | 60 | Process area noise |
| 1 | 1010 | 2-5 W | 42-49 | 42-54 | 41-50 | 40-47 | 43-55 | 40-55 | 46 | Process area, jet noise |
| 2 | 1218 | 5-10 W | 35-42 | 33-42 | 33-38 | 35-38 | 35-40 | 33-42 | 37 | Process area noise |
| 3 | 1212 | 0-5 W | 31-39 | 30-34 | <30-36 | <30-38 | <30 | -- | -- | |
| 4 | 1420 | 5-10 S | 33-40 | 31-36 | 30-34 | <30 | <30-35 | -- | -- | |
| 5 | 1347 | 2-5 SW | <30 | <30 | <30-31 | <30-32 | <30-35 | -- | -- | |
| 6 | 1400 | 0-3 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 7 | 1426 | 5-10 W | 38-46 | 37-42 | 36-47 | 34-38 | 32-37 | 32-47 | 39 | Process area, jet noise |
| 8 | 1135 | 5-10 W | <30 | <30 | <30-36 | <30-36 | <30 | -- | -- | |
| 9 | 1145 | 8-12 W | 30-48 | 30-45 | 30-48 | <30-44 | <30-43 | -- | -- | Wind noise |
| 10 | 1153 | 2-5 W | <30 | <30-33 | <30-35 | <30 | <30 | -- | -- | |
| 11 | 1410 | 5-10 W | <30-37 | <30 | <30 | <30-33 | <30-36 | -- | -- | |
| 12 | 1340 | Calm | 33-40 | 31-35 | 30-42 | 30-42 | 38-46 | 30-46 | 37 | Oil & gas drilling activity, jet noise |
| 13 | 1128 | 0-5 W | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 14 | 1117 | 8-12 W | 59-63 | 43-57 | 42-55 | 42-54 | 42-56 | 42-63 | 51 | Oil & gas drilling activity, wind noise |
| 15 | 1107 | 8-12 W | <30-32 | <30-38 | 35-42 | 31-39 | 34-41 | -- | -- | |
| 16 | 1205 | 8-12 W | 33-40 | 33-38 | 31-34 | 30-40 | 33-48 | 30-48 | 36 | Road traffic, wind noise |
| A | 1435 | 4-8 W | 61-63 | 61-63 | 61-66 | 61-64 | 61-63 | 61-66 | 62 | |

[1/] Representative sound level averages cannot be computed in some instances because measurements were below the minimum threshold of the instrument

Table 2-39. Environmental Sound Level Measurements Tract C-a, May 14, 1982

| Site | Time | Wind | Sound Level Measurements (dBA, Slow Response) (20 sec range) 1 | 2 | 3 | 4 | 5 | Sound Level Range (dBA) | Sound Level Average (dBA) [1/] | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0950 | 0-3 N | 60-62 | 60-62 | 61-63 | 60-62 | 60-63 | 60-63 | 61 | Process area noise |
| 1 | 1007 | 2-8 NE | 30-33 | 30-36 | 30-42 | 30-35 | 30-37 | 30-42 | 33 | |
| 2 | 1208 | 0-5 E | <30 | <30-35 | <30-36 | <30-37 | <30 | -- | -- | |
| 3 | 1200 | 0-3 E | 37-40 | 38-41 | 34-37 | 35-41 | 33-39 | 33-41 | 38 | |
| 4 | 1114 | 2-6 E | <30-32 | <30 | <30-31 | <30-33 | <30 | -- | -- | |
| 5 | 1042 | 2-8 NE | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 6 | 1053 | 2-8 E | <30 | <30-38 | <30-33 | <30 | <30-36 | -- | -- | |
| 7 | 1154 | 2-5 E | <30-35 | <30-34 | <30-36 | <30-34 | <30-34 | -- | -- | |
| 8 | 1330 | 0-3 NE | 32-45 | 30-45 | 48-58 | 31-40 | 30-35 | 30-58 | 39 | Truck traffic, bird noise |
| 9 | 1313 | 0-2 W | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 10 | 1319 | Calm | <30-43 | <30 | <30 | <30-39 | <30 | -- | -- | |
| 11 | 1105 | 2-6 E | <30-33 | <30 | <30-32 | <30-40 | <30-41 | -- | -- | |
| 12 | 1033 | 2-8 NE | <30-37 | 30-38 | 30-39 | 32-41 | 32-39 | -- | -- | |
| 13 | 1403 | Calm | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 14 | 1356 | 0-2 NE | 39-46 | 33-40 | 36-39 | 34-39 | 33-37 | 33-46 | 38 | |
| 15 | 1345 | 0-3 NE | <30 | <30 | <30 | <30-33 | <30 | -- | -- | |
| 16 | 1412 | Calm | <30-35 | <30 | <30 | <30-33 | <30 | -- | -- | |
| A | 1438 | Calm | 63-65 | 63-65 | 63-65 | 63-65 | 63-65 | 63-65 | 64 | Process Area noise |

[1/] Representative sound level averages cannot be computed in some instances because measurements were below the minimum threshold of the instrument

Table 2-40. Environmental Sound Level Measurements Tract C-a, August 16, 1982

| Site | Time | Wind | Sound Level Measurements (dBA, Slow Response) (20 sec range) 1 | 2 | 3 | 4 | 5 | Sound Level Range (dBA) | Sound Level Average (dBA) [1/] | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0925 | 0-2 NE | 62-64 | 62-64 | 62-64 | 62-64 | 62-64 | 62-64 | 63 | Process area noise |
| 1 | 0935 | 0-3 NE | <30 | <30 | <30-35 | <30-34 | <30-35 | -- | -- | |
| 2 | 0941 | 0-2 NE | <30-34 | <30 | <30-36 | <30-33 | <30-36 | -- | -- | |
| 3 | 1150 | Calm | 40-42 | 39-43 | 37-42 | 36-40 | 34-39 | 34-43 | 39 | |
| 4 | 1103 | 2-5 E | 31-35 | 31-36 | 33-42 | 31-44 | 31-35 | 31-44 | 35 | Process area, jet noise |
| 5 | 1128 | 2-5 S | <30 | <30-41 | <30 | <30 | <30-37 | -- | -- | |
| 6 | 1120 | 0-2 E | 33-41 | 30-35 | 30-36 | 36-44 | <30-37 | -- | -- | Grasshoppers, process area noise |
| 7 | 1054 | 2-5 NE | <30 | <30 | <30 | <30-32 | <30 | -- | -- | |
| 8 | 1021 | 2-4 NE | <30 | <30 | <30 | <30-32 | <30 | -- | -- | |
| 9 | 1030 | 0-3 E | 30-39 | 30-38 | 30-36 | <30-33 | <30-31 | -- | -- | Wind noise |
| 10 | 1036 | 0-2 E | 35-47 | 34-40 | 35-45 | 38-44 | 37-49 | 34-49 | 40 | Jet, insect noise |
| 11 | 1109 | 0-2 E | <30 | <30 | <30-35 | 30-35 | 30-33 | -- | -- | |
| 12 | 1134 | 2-5 E | <30 | <30 | <30-35 | <30-34 | <30 | -- | -- | |
| 13 | 0952 | 0-2 NE | <30 | <30 | <30 | <30 | <30-37 | -- | -- | |
| 14 | 1000 | 0-4 E | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 15 | 1008 | 1-3 NE | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 16 | 1047 | 0-3 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| A | 1158 | 0-2 SW | 63-64 | 63-65 | 62-64 | 63-64 | 63-64 | 62-65 | 64 | |

[1/] Representative sound level averages cannot be computed in some instances because measurements were below the minimum threshold of the instrument

Table 2-41. Environmental Sound Level Measurements Tract C-a, November 16, 1982

| Site | Time | Wind | Sound Level Measurements (dBA, Slow Response) (20 sec range) 1 | 2 | 3 | 4 | 5 | Sound Level Range (dBA) | Sound Level Average (dBA) [1/] | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0848 | Calm | 54-58 | 55-61 | 54-59 | 56-60 | 53-55 | 53-61 | 57 | Process area noise |
| 1 | 1322 | 0-4 SW | 31-33 | 30-35 | 30-32 | <30 | <30 | -- | -- | |
| 2 | 1147 | 0-3 E | <30 | <30 | <30 | <30 | <30-31 | -- | -- | |
| 3 | 1140 | Calm | <30 | <30-31 | <30 | <30 | <30 | -- | -- | |
| 4 | 1042 | 0-3 E | <30-35 | <30 | <30 | <30 | <30 | -- | -- | |
| 5 | 1024 | Calm | 30-39 | <30-33 | <30 | <30 | <30 | -- | -- | |
| 6 | 1034 | Calm | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 7 | 1100 | 0-3 E | <30-37 | <30-32 | <30 | <30 | <30 | -- | -- | |
| 8 | 1448 | 0-2 NE | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 9 | 1505 | Calm | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 10 | 1457 | 2-5 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 11 | 1049 | Calm | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 12 | 1016 | Calm | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 13 | 1439 | 0-2 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 14 | 1416 | 2-5 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 15 | 1428 | 2-5 SW | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| 16 | 1132 | 0-3 E | <30 | <30 | <30 | <30 | <30 | -- | -- | |
| A | 1515 | Calm | 46-47 | 46-47 | 46-48 | 46-47 | 46-48 | 46-48 | 47 | Process area noise |

[1/] Representative sound level averages cannot be computed in some instances because measurements were below the minimum threshold of the instrument

## 2.7 SUMMARY

Both air quality and meteorological data were collected at sites near Tract C-a during 1982. No violation of any National Ambient Air Quality Standard NAAQS was detected. Considering the very low activity level on and around the tract, this result is not surprising. With the exception of ozone and total suspended particulates (TSP), concentrations of all air quality parameters were found to be near or below the threshold of detection of the state-of-the-art instruments used in the monitoring program.

The range of ozone concentrations recorded during 1982 was 0.016 to 0.078 ppm. This range of concentrations is very similar to that found in previous years, and appeared to be uninfluenced by the decrease in site activity. This lends support to the hypothesis advanced in earlier reports that the source of the ozone concentrations is located elsewhere (e.g., ozone is brought in by long range transport or stratespheric injection).

Although peak summertime concentrations of TSP in 1982 are similar to concentrations in 1981 and 1980 (approximately one-half of the secondary NAAQS for TSP), the annual geometric mean concentrations have dropped substantially. This drop in TSP concentrations has been greatest at Site 3, which was probably impacted in earlier years by activity on and around the tract. At present, all three TSP sites appear to be measuring primarily background concentrations, with little impact due to localized activity. Correlations of the TSP data sets on an annual basis among the three sites were very high, averaging 0.92.

The meteorological data from 1982 showed that the year was slightly cooler and wetter than previous years. The annual temperature range of 56 C included the coldest temperature (-26.2C) recorded at Site 1 during the monitoring program. Precipitation at the tract totalled approximately 16 inches during 1982, compared to a mean of 14 1/2 inches over the past five years.

The mean annual visual range in 1982 was 93 miles, which is a slight increase from 86 miles in 1981, 85 miles in 1980, and 79 miles during the baseline. A mean daily visual range of 174 miles measured during the spring was the highest daily average found during the entire monitoring program. The most unusual finding in the 1982 visibility study was the higher average visual range in the spring compared to the fall, when all previous years found that fall had higher visual ranges. However, it is very likely that this situation was simply caused by the ten sampling days in the spring falling during periods when meteorological conditions were abnormally good for visibility.

Four noise surveys were taken during 1982. The measured sound levels generally ranged from less than 30 dBA (the threshold of the instrument) to 45 dBA, except near the main construction area (adjacent to the headframe), which averaged 60 dBA. If the measurements taken near the main construction area are excluded, these sound levels are comparable to data taken during the baseline period.

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# SECTION 3
# TERRESTRIAL STUDIES

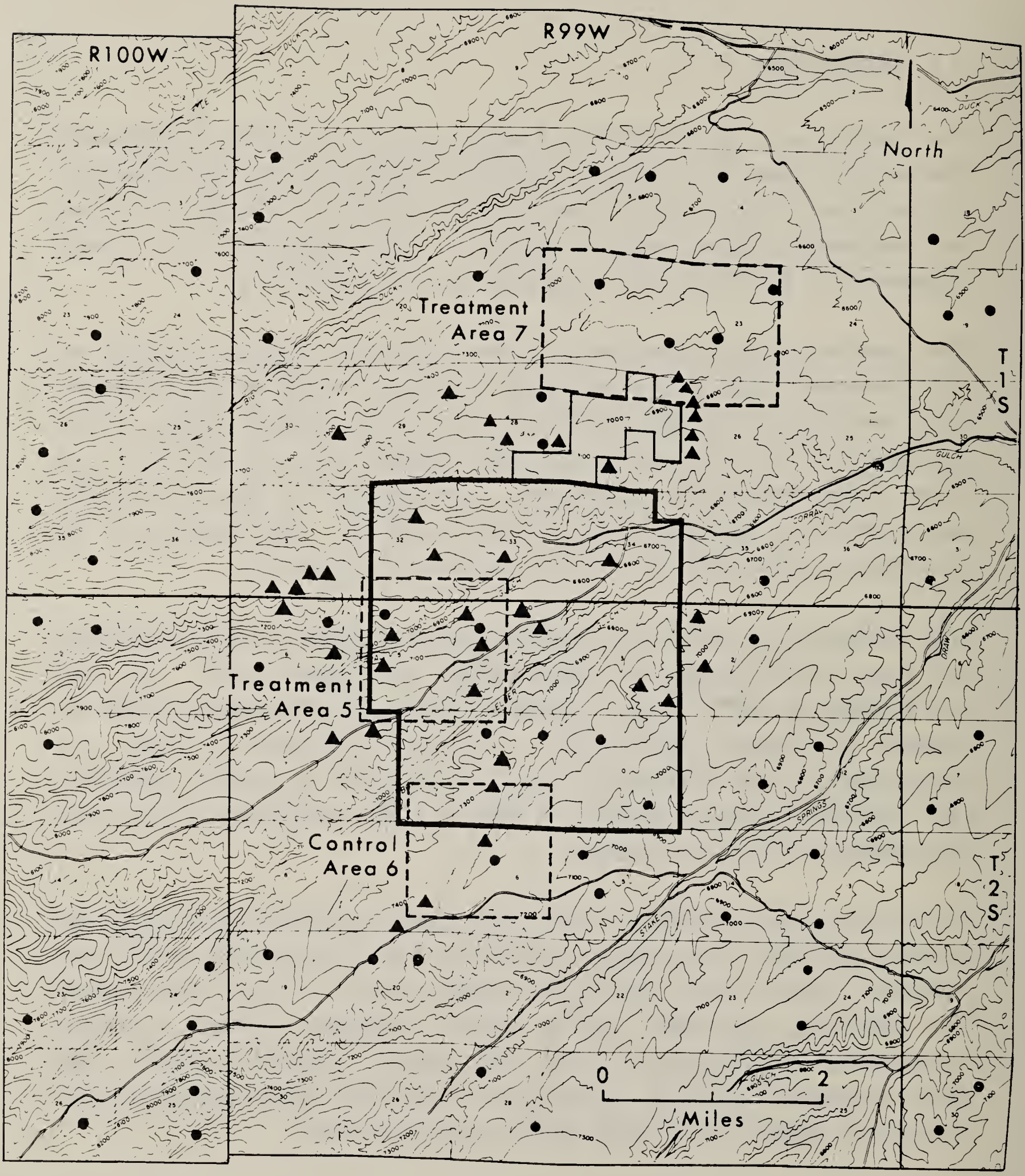
## 3.0 INTRODUCTION

The objective of the Terrestrial Studies portion of the MDP Environmental Monitoring Program is to conduct monitoring required by the environmental stipulations in the Tract C-a lease, and to detect and evaluate (in terms of development-related impact) changes in the vegetative or faunal components of the terrestrial ecosystems on or near Tract C-a.

The sampling program associated with the Terrestrial Studies is geared to the seasonal cycles of the ecosystems involved. During the 1982 reporting year, monitoring of browse condition and utilization, phytosociology, range productivity and utilization, mule deer density, mule deer road kill, and feral horse abundance was conducted. The results of these monitoring activities are reported in this section of MDP 11. The locations of the Terrestrial Studies monitoring sites are shown in Figure 3-1.

The design of the Terrestrial Studies program is based on current knowledge of Tract C-a ecosystems and RBOSC project development plans. As the development of Tract C-a is a pioneering effort, such development plans are subject to frequent modification. The basic knowledge of Tract C-a ecosystems is also increasing. These factors result in frequent changes to the Terrestrial Studies portion as well as other components of the MDP Environmental Monitoring Program.

Terrestrial data presented in this report were collected according to the methods described in the Modular Development Phase Environmental Monitoring Program Scope of Work, Revision 6.1 (RBOSC 1981a). All data were verified in compliance with RBOSC quality control procedures, which included supervisory verification of field data sheets, laboratory analysis, and data management processes. Documentation supporting these quality control procedures appears in the RBOSC Quality Assurance files.




- Mule Deer Pellet Group Sample Unit
- Range-Browse, Productivity & Utilization Study Site
- Intensive Study Sites

Figure 3-1. Terrestrial Ecology Monitoring Sites.

## 3.1 VEGETATION, RANGE, and BROWSE

### A. Vegetation Mapping and Stress

#### 1. Objectives

Construction and operation of Tract C-a facilities may affect the local distribution and/or condition of vegetation types. Therefore, these vegetation mapping and stress studies are designed to monitor the distribution of plant communities on Tract C-a and adjacent areas in order to determine large-scale changes resulting from MDP development, to identify stress conditions, and to document changes in the plant communities over time.

#### 2. Methods

Because of changes in the development schedule for Tract C-a, the assessment of vegetation stress via color infrared (CIR) aerial photography (scale, 1 inch = 500 feet) has been deleted from the terrestrial monitoring program. No data were collected during 1982; however, baseline data are available for 1974, 1979, 1980 and 1981.

#### 3. Results

Analyses of the 1981 data, as well as comparisons with previous years, will be presented in subsequent reports as these results become available.

### B. Browse Condition and Utilization

#### 1. Objectives

Tract C-a development may reduce or alter browse availability and therefore may affect the distribution of deer in the vicinity of Tract C-a. The browse condition and utilization studies are designed to provide browse information for areas adjacent to proposed development. These data provide

values for comparison with baseline conditions and also will be useful for comparative studies once commercial development occurs.

## 2. Methods

The methods for collection of browse data were described in RBOSC MDP Monitoring Reports 1, 2 and 9 (RBOSC 1978a, 1978b, 1982a). Browse condition for this report period was assessed between April 23-30, 1982.

Leader use values (%) for each species within the three vegetation types were arcsine transformed and analyzed using the following two-way analysis of variance (ANOVA), which compares use among years and among transects.

| Source of Variation | Degrees of Freedom | F-Test |
|---|---|---|
| A. Year (phase of development) | a-1 | A/D |
| B. Transect | b-1 | B/D |
| C. Year x Transect | (a-1)(b-1) | C/D |
| D. Error | ab(n-1) | |
| | Total abn-1 | |

Leader use values (%) from the 1982 sampling period for each species within the three vegetation types were also arcsine transformed and analyzed by the following one-way ANOVA.

| Source of Variation | Degrees of Freedom | F-Test |
|---|---|---|
| A. Transect | a-1 | A/B |
| B. Error | a(n-1) | |
| | Total an-1 | |

## 3. Results and Discussion

Data obtained during the 1982 sampling period are summarized in Table 3-1 and presented in their entirety in Appendix 3-1 of MDP Monitoring Report 10

Table 3-1. Condition of Important Browse Species in Three Vegetation Types During April-May 1982 in the Vicinity of Tract C-a.

| Vegetation Type[1] | Species | Number of Plants Sampled | Avg. Util. (%)[2] | Avg. Avail. (%)[2] | Form Class (%)[3] | | | | | | | | Age Class (%)[2] | | | | Hedging Class (%)[2] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Seedling | Young | Mature | Decadent | Light | Moderate | Severe |
| MB | Serviceberry | 117 | 5 | 89 | 28 | 24 | 7 | 15 | 11 | ... | 1 | 15 | ... | 5 | 32 | 63 | 51 | 41 | 8 |
| | Sagebrush | 61 | 11 | 96 | 23 | 48 | 8 | 3 | 8 | ... | ... | 10 | ... | ... | 59 | 41 | 29 | 62 | 9 |
| | Snowberry | 39 | 2 | 70 | 18 | 8 | ... | 46 | 8 | ... | 8 | 13 | ... | 13 | 36 | 51 | 81 | 19 | ... |
| | Mountain Mohogany | 4 | 5 | 100 | 25 | ... | ... | ... | ... | ... | 50 | 25 | 50 | ... | ... | 50 | 100 | ... | ... |
| | Pinyon Pine | 4 | 0 | 100 | 100 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 75 | 25 | 100 | ... | ... |
| PJ | Sagebrush | 184 | 19 | 87 | 26 | 22 | 7 | 9 | 15 | 7 | 1 | 14 | ... | 2 | 40 | 58 | 41 | 44 | 15 |
| | Juniper | 71 | <1 | 34 | 8 | ... | ... | 65 | 1 | ... | 8 | 17 | ... | 1 | 49 | 49 | 98 | 2 | ... |
| | Pinyon Pine | 67 | 2 | 48 | 13 | 3 | ... | 67 | 6 | ... | 7 | 3 | 1 | ... | 82 | 12 | 90 | 10 | ... |
| | Bitterbrush | 30 | 47 | 90 | 17 | 20 | 20 | 3 | 13 | 20 | ... | 7 | ... | ... | 33 | 67 | 21 | 36 | 43 |
| | Mountain Mahogany | 28 | 38 | 91 | 14 | 43 | 18 | ... | 4 | 21 | ... | ... | ... | ... | 39 | 61 | 14 | 46 | 39 |
| | Serviceberry | 14 | 7 | 94 | ... | 50 | 29 | 7 | ... | ... | ... | 14 | ... | ... | 43 | 57 | 8 | 58 | 33 |
| | Snowberry | 6 | 8 | 86 | ... | ... | 33 | 50 | ... | ... | ... | 17 | ... | 17 | 33 | 50 | 60 | 40 | ... |
| SB | Sagebrush | 357 | 12 | 97 | 32 | 31 | 4 | 4 | 6 | <1 | ... | 22 | ... | 1 | 37 | 62 | 47 | 48 | 6 |
| | Serviceberry | 10 | 4 | 82 | ... | 20 | 50 | 20 | ... | ... | ... | 10 | ... | 20 | 50 | 30 | 56 | 44 | ... |
| | Snowberry | 4 | 0 | 47 | ... | ... | ... | 25 | 50 | ... | ... | 25 | ... | ... | 25 | 75 | 33 | 67 | ... |
| | Juniper | 3 | 0 | 62 | 33 | ... | ... | 67 | ... | ... | ... | ... | ... | ... | 100 | ... | 100 | ... | ... |
| | Pinyon Pine | 1 | 0 | 70 | ... | ... | ... | 100 | ... | ... | ... | ... | ... | ... | 100 | ... | 100 | ... | ... |

... indicates no individuals present in this category

1/ MB = Mixed Brush
PJ = Pinyon-Juniper
SB = Sagebrush

2/ Data are based on form classes 1-6

3/ Form Classes

1 All available, little or no hedging
2 All available, moderately hedged
3 All available, severely hedged
4 Partially available, little or no hedging
5 Partially available, moderately hedged
6 Partially available, severely hedged
7 Unavailable
8 Dead

(RBOSC 1982b). Results of Duncan's Multiple Range Tests for significant main effect differences among years and/or transects are illustrated in Appendix 3-1.1 of this report.

a. Mixed Brush - Leader use in the Mixed Brush vegetation type in 1982 ranged from zero for pinyon pine (Pinus edulis) to 11 percent for sagebrush (Artemisia tridentata) (Table 3-1). When compared to data collected during 1981 (RBOSC 1982a), the use of sagebrush had increased from six to 11 percent. Decreased use was evident for serviceberry (Amelanchier utahensis; 7 to 5 percent), snowberry (Symphoricarpos oreophilus; 5 to 2 percent) and pinyon pine (<1 to 0 percent) for the same period. Leader use of mountain mahogany (Cercocarpos montanus) remained at five percent during both years.

The weighted average utilization for all species sampled within the Mixed Brush type was six percent during both the 1981 and 1982 sample periods (Table 3-2). Based on Cole's (1963) classification levels for use of vigorous, mature plants on winter range, all of the species sampled were judged to have "allowable" leader use rates for mild winter conditions.

Table 3-2. Comparison of Weighted Average Browse Utilization (%) of Seven Shrub and/or Tree Species in Three Vegetation Types During 1976 through 1982 on and Near Tract C-a[1/]

| Vegetation Type | April 1976 | April 1977 | May 1978 | May 1979 | May 1980 | May 1981 | May 1982 |
|---|---|---|---|---|---|---|---|
| Mixed Brush | 12 | 17 | 7 | 8 | 4 | 6 | 6 |
| Pinyon-Juniper | 27 | 24 | 31 | 15 | 10 | 9 | 16 |
| Sagebrush | [2/] | 6 | 25 | 4 | 1 | 5 | 12 |

1/ $\bar{W}\bar{x}_{ij} = \dfrac{\sum_{i=1}^{j} (\bar{x}_i n)}{\sum_{i=1}^{N} N_{ij}}$ Where $\bar{W}\bar{x}$ is the weighted average utilization, N = 250 for 1976-1980, and 225, 400 and 375 for MB, PJ and SB, respectively during 1981 and 1982.

2/ Data not available for 1976

Leader use varied significantly among Mixed Brush transects for both serviceberry and sagebrush (Table 3-3). Serviceberry use was lower on Transect 31 to the north of Tract C-a than on three of the eight remaining transects. Lower utilization on this transect may be related to the abundance of serviceberry and fewer deer per square mile than for other areas around Tract C-a. Sagebrush was browsed significantly more on Transect 34 than on the seven other Mixed Brush transects where it was encountered (see Duncan's Multiple Range Results, Appendix 3-1.1). It is unclear why leader use varies for sagebrush and not for other species on the same transect. These data seem to indicate that species preferences (or subspecies differences in the case of sagebrush) may be more important than site conditions in influencing browse utilization.

When leader use was compared for all years sampled, significant main effect differences were again noted for both serviceberry and sagebrush within the Mixed Brush type (Table 3-4). Although use patterns were complex, serviceberry appeared to be consistently less heavily browsed on Transect 31 than three transects located 2.5 km to the south. Nevertheless, leader use for serviceberry during 1982 was not significantly different from that recorded for any other sampling period (Appendix 3-1.1). Leader use for sagebrush along Transect 34 continued to be significantly greater than for all other Mixed Brush transects (see Duncan's Multiple Range Test results, Appendix 3-1.1).

Because the same individuals are sampled each year for any given transect, there were only minor variations noted between 1981 and 1982 data for the distribution of species by form, age and hedging classification. Range condition ratings based on the percent of decadent individuals (those with greater than 25 percent of the crown dead) within the Mixed Brush type continue to be "poor" for sagebrush and "very poor" for serviceberry and snowberry. Mountain mahogany would be judged to be in fair condition based on Cole's (1963) rating system. The same rating system based on hedging classification indicated that the condition rating was excellent, which is to say that no species sampled had greater than 10 percent of the individuals exhibiting severe hedging.

Table 3-3. Summary of One-way ANOVA Results Comparing Browse Leader Use for 1982, Tract C-a[1/]

| Vegetation Type | Species | Source of Variation: Among Transects F | PR>F[2/] |
|---|---|---|---|
| MB | Serviceberry | 2.22* | 0.0328 |
| | Sagebrush | 6.04** | 0.0001 |
| | Snowberry | 0.85 | 0.5574 |
| | Mountain Mahogany[3/] | ... | ... |
| | Pinyon Pine[4/] | ... | ... |
| PJ | Sagebrush | 3.45** | 0.0001 |
| | Pinyon Pine | 1.44 | 0.1774 |
| | Juniper | 2.22* | 0.0258 |
| | Bitterbrush | 4.93** | 0.0021 |
| | Mountain Mahogany | 5.89** | 0.0020 |
| | Snowberry | 0.36 | 0.5898 |
| | Serviceberry | 0.73 | 0.5067 |
| SB | Sagebrush | 7.31** | 0.0001 |
| | Serviceberry | 0.59 | 0.6868 |
| | Snowberry[3/] | ... | ... |
| | Pinyon Pine[3/] | ... | ... |
| | Juniper[5/] | ... | ... |

* significant at $\alpha = 0.05$

** significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 3-1.1.

2/ PR>F represents the significance probability ($\alpha$) associated with F.

3/ Species present only on one transect.

4/ Insufficient data to produce ANOVA results.

5/ No leader use was noted.

Table 3-4. Summary of Two-way ANOVA Results Comparing Browse Leader Use from 1978 through 1982, Tract C-a[1/]

| Vegetation Type | Species | Source of Variation: Year F | Year PR>F[2/] | Among Transects F | Among Transects PR>F[2/] | Year x Transect F | Year x Transect PR>F[2/] |
|---|---|---|---|---|---|---|---|
| MB | Serviceberry | 3.77** | 0.0049 | 7.16** | 0.0001 | 1.51* | 0.0389 |
| | Sagebrush | 0.99 | 0.4163 | 5.22** | 0.0001 | 2.16** | 0.0019 |
| | Snowberry | 1.11 | 0.3549 | 2.01 | 0.0578 | 0.74 | 0.8190 |
| | Mountain Mahogany[3/] | 0.73 | 0.6069 | ... | ... | ... | ... |
| | Pinyon Pine[4/] | ... | ... | ... | ... | ... | ... |
| PJ | Sagebrush | 15.98** | 0.0001 | 4.26** | 0.0001 | 2.79** | 0.0001 |
| | Pinyon Pine | 5.93** | 0.0002 | 4.38** | 0.0001 | 1.79** | 0.0046 |
| | Juniper | 1.09 | 0.3658 | 1.19 | 0.2898 | 1.53* | 0.0370 |
| | Bitterbrush | 23.47** | 0.0001 | 6.84** | 0.0001 | 1.44 | 0.1122 |
| | Mountain Mahogany | 14.76** | 0.0001 | 19.31** | 0.0001 | 4.64** | 0.0001 |
| | Snowberry | 5.40** | 0.0060 | 0.03 | 0.8577 | 0.05 | 0.9949 |
| | Serviceberry | 3.65** | 0.0114 | 2.85 | 0.0679 | 2.91** | 0.0102 |
| SB | Sagebrush | 83.92** | 0.0001 | 11.76** | 0.0001 | 6.70** | 0.0001 |
| | Serviceberry | 1.41 | 0.2636 | 0.53 | 0.7166 | 1.02 | 0.4784 |
| | Snowberry[5/] | 0.92 | 0.4791 | ... | ... | ... | ... |
| | Pinyon Pine[6/] | ... | ... | ... | ... | ... | ... |
| | Juniper [6/] | ... | ... | ... | ... | ... | ... |

* significant at $\alpha = 0.05$

** significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Tests results for significant main effects are presented in Appendix 3-1.1.

2/ PR>F represents the significance probability ($\alpha$) associated with F.

3/ Species present on only one transect; therefore, source of variation occurs only among years.

4/ Insufficient data to produce ANOVA results.

5/ Species leader usage only in 1981; therefore, source variation occurs only among years.

6/ No leader use was noted.

Range condition ratings based on hedging classification more readily reflect changes in browse utilization than do those based on age classification. For example, during the 1979 sampling season which followed several years when the average number of deer per square mile ranged from 43 to 50 during the Winter period, the percentage of severely hedged shrubs was higher than at present. It is reasonable to assume that the lower numbers of severely hedged shrubs during 1982 are related to the reduced size of the deer herd after 1979.

b. Pinyon-Juniper - Leader use in the Pinyon-Juniper vegetation type ranged from less than one for juniper to 47 percent for bitterbrush (Table 3-1). Browse pressure on mountain mahogany was also high (38 percent), with both bitterbrush (Purshia tridentata) and mountain mahogany exhibiting slightly higher use during 1982 than that recorded for 1981 (RBOSC 1982a). Leader use on snowberry increased from zero in 1981 to eight percent in 1982; however, this included only five living individual shrubs so that it did not represent a large volume of material. The recorded use of sagebrush, on the other hand, increased three-fold (from 6 percent in 1981 (RBOSC 1982a) to 19 percent during 1982 for 156 living individuals). It is interesting to note that utilization of bitterbrush and mountain mahogany increased only slightly while the increase for sagebrush was dramatic. It seems reasonable to assume that, with increased browse pressure and a limited number of bitterbrush and mountain mahogany shrubs, sagebrush is the alternate browse source as deer herds increase in size. Leader use for bitterbrush and mountain mahogany was within "allowable" limits for average winters, whereas all other species in the Pinyon-Juniper type were utilized at levels expected for mild winters (Cole 1963).

Weighted average utilization within the Pinyon-Juniper vegetation type increased to 16 percent during 1982 from the six year low of 9 percent recorded during 1981 (Table 3-2). The use during 1982 was similar to that noted during the 1979 sample period. Because of the large proportion of sagebrush shrubs sampled, the 1982 increase was due, in large part, to the substantial increase in use of that species.

Browse use on four of the seven species sampled during 1982 differed significantly among the fifteen Pinyon-Juniper transects (Table 3-3). Sagebrush leader use was significantly higher on Transect 12, located to the east of the MIS facility, than on seven other transects, most of which were located on Dead Horse Ridge (see Duncan's Multiple Range Test results, Appendix 3-1.1). However, the leader use estimate for transect 12 was based on only three sagebrush individuals whereas each of the other 13 Pinyon-Juniper transects averaged 10 sagebrush plants sampled. Use of mountain mahogany was found to be significantly lower on Transect 6 than three of the four other transects where it was sampled. All but one transect had nonsignificant variations in leader use of juniper (Juniperus osteosperma) individuals. Transect 17, the exception, had significantly higher use of juniper than the fourteen other Pinyon-Juniper sites. No pattern of use variation relative to site location was evident for either mountain mahogany or juniper. Similarly, although significant variations in leader use are indicated for bitterbrush, the Duncan's Multiple Range Test grouping of transects does not suggest an obvious pattern of use.

When five years of data were compared, similar variations among transects as well as among years were evident (Table 3-4). Transect 12 continued to stand out as having significantly higher use of sagebrush than any of the other transects. Leader use for sagebrush, mountain mahogany, pinyon pine and bitterbrush was significantly higher during 1978 than any other sampling period. Utilization of sagebrush during 1982 was significantly higher than all years except 1978 (see Duncan's Multiple Range Test results, Appendix 3-1.1).

Range condition, based on the percentage of decadent individuals, deteriorated for species within the Pinyon-Juniper vegetation type during 1982 as compared to 1981. The condition of sagebrush, bitterbrush, mountain mahogany, serviceberry and snowberry would be rated as "very poor" because at least 50 percent of the individuals had dead regions totalling 25 percent of their crown areas (Cole 1963). Juniper had a "poor" rating and pinyon pine a "good" rating. Ratings based on the percentage of severely hedged plants were somewhat better than those predicated on the

basis of age classification. No severely hedged individuals were noted for juniper, pinyon pine or snowberry. Sagebrush condition would be judged as "good", and bitterbrush, mountain mahogany and serviceberry were rated as being in "poor" condition.

As noted for the Mixed Brush type, changes in hedging classification were more evident among years than were variations in age classification for the Pinyon-Juniper vegetation type. For example, 34 percent of the 103 sagebrush plants sampled in 1979 were classified as severely hedged. During 1982 only 15 percent of the individuals were categorized as such. This marked decrease was due, in part, to the inclusion (during 1981) of five new transects where sagebrush hedging was not as severe as noted at sites sampled during 1979. However, decreased browsing pressure for the same period undoubtedly contributed to the more favorable condition rating as based on hedging.

c. Sagebrush - Sagebrush and serviceberry were the only species sampled which exhibited leader use, 12 and 4 percent respectively, within the Sagebrush vegetation type, (Table 3-1). Sagebrush use increased and serviceberry use decreased relative to 1981; nevertheless, both species evidenced use which would be judged "allowable" for mild winters (Cole 1963).

The weighted average utilization within the sagebrush type increased from 5 percent in 1981 (RBOSC 1982a) to 12 percent in 1982 (Table 3-2). It is reasonable to assume that increased use during 1982 is related in part to the rebound in deer herd size which has occurred subsequent to the large winter kill of 1978-1979. Browse use during 1982 was approximately half that recorded for 1978, when the weighted average utilization reached 25 percent.

A comparison of utilization among the fifteen transects sampled in 1982 showed that significant differences exist for sagebrush leader use (Table 3-3). Duncan's Multiple Range Test results (Appendix 3-1.1) illustrate the complex relationships among transects. Browse use on

Transect 10 was similar to that on Transect 8 but significantly higher than on any of the other sites sampled. It is interesting to note that both of these transects are in close proximity to the MIS facility, indicating that development activities are not adversely influencing deer use patterns.

Multiple year comparisons indicated that use of sagebrush along Transects 10 and 8 was consistently higher than for most other sites (Table 3-4, Appendix 3-1.1). These analyses also illustrated the differences noted in the average weighted utilization values presented on Table 3-2. Leader utilization for sagebrush during 1978 was significantly higher than for any other sample period. Use during 1982, although significantly lower than for 1978, was significantly higher than for the 1979-1981 period.

Range condition ratings based on the percentages of decadent plants indicated that both sagebrush and snowberry were in "poor" condition, with serviceberry being classified as being in "fair" condition (Cole 1963). The ratings for all species except sagebrush were based on a relatively few individuals (Table 3-1) and may not provide an accurate reflection of range condition. Condition ratings based on the percentage of severely hedged plants provide an alternate perspective. Sagebrush was the only species with severely hedged plants (6 percent) and thus would be categorized as being in "excellent" condition.

## C. Phytosociological Studies

### 1. Objectives

The objective of the phytosociological studies is to monitor the species composition and cover in the major vegetation types expected to be affected by Tract C-a development. These studies provide quantitative data which complement information on the distribution of major habitat types and provide continuity with similar data collected during the baseline period.

## 2. Methods

The methods used to collect these data were presented in MDP Monitoring Reports 5 and 9 (RBOSC 1980, 1982a). Data are collected from one "control" area (6) and two "treatment" areas (5 and 7) on or adjacent to Tract C-a. Treatment areas are located in sites which are expected to receive impacts from retort emissions, whereas the control site is located outside the region which may be affected.

With data available from multiple years for all three study sites, comparisons of arcsine transformed cover estimates for herbaceous species were accomplished using the following two-way, nested analysis of variance (ANOVA):

| Source of Variation | Degrees of Freedom | F-Ratio | Expected Mean Squares |
|---|---|---|---|
| A. Site | $a-1$ | $A/B$ | $\sigma^2 + n\sigma^2_{BA} + \frac{bc}{a-1}\sum^{a}\alpha^2$ |
| B. Transect within Site | $a(b_i-1)$ | $B/F$ | $\sigma^2 + n\sigma^2_{BA} + \frac{ac}{a(b_i-1)}\sum^{B}\beta^2$ |
| C. Year | $c-1$ | $C/F$ | $\sigma^2 + \frac{ab}{c-1}\sum^{c}\gamma^2$ |
| D. Site x Year | $(a-1)(c-1)$ | $D/F$ | $\sigma^2 + \frac{B\ A}{(a-1)(c-1)}\sum^{ac}(\alpha\gamma)^2$ |
| E. Transect Within Site x Year | $[a(b_i-1)](c-1)$ | $E/F$ | $\sigma^2 + \frac{a}{a(b_i-1)(c-1)}\sum^{bc}(\beta\gamma)^2$ |
| F. Error | $ab_ic(n-1)$ | | $\sigma^2$ |
| TOTAL | $(nab_ic)-1$ | | |

This nested or hierarchical, two-way ANOVA is used to detect differences in the percent herbaceous cover between three sites (main effect A), among five transects within each site (nested effect B), and between years (before versus during development, main effect C). The interaction effect (D) tests differences among sites by year, while the interaction effect (E) tests the differences among transects, within each site by year.

The F-ratios (in the aforementioned ANOVA) test the homogeneity of the variances within each treatment (A-D); thus, significant F tests imply that not all treatment combinations within an effect come from the same sample population. Therefore, significant interaction and main effects are tested to identify differences among means within response variables using a Duncan's Multiple Range Test.

## 3. Results and Discussion

Phytosociological studies were conducted June 15-22, 1982. The resultant data are summarized herein, with the entire data set being presented in Appendix 3-3 of MDP Monitoring Report 10 (RBOSC 1982b).

a. Pinyon-Juniper - Percent cover of herbaceous species in the Pinyon-Juniper vegetation type ranged from 11.3 in Area 6 to 15.2 in Area 7. Species richness of forbs far exceeded that of grasses; however, few forb species averaged over one percent cover within a given study area (Tables 3-5, 3-7, 3-9). Grasses accounted for the largest portion of the total cover, ranging from 6.6 to 10.4 percent in Areas 6 and 7 respectively (Tables 3-6, 3-8, 3-10). Bluegrass (Poa) and wheatgrass (Agropyron) species contributed the largest proportion of grass cover.

A comparison among study areas and sampling periods showed no significant differences in cover of grasses or forbs, based on the main effects of the nested ANOVA used (Table 3-11). However, it is interesting to note that some variations among main effects are approaching significance at the five percent level. Variations in cover of grasses, based on the main effects area and report years, are examples. Such differences are not all together unexpected between years because of variations in available moisture or other climatic factors. But, to this point in the phytosociological monitoring program, differences among study areas have not been evident, as indicated by the nested ANOVA.

b. Sagebrush - Cover of herbaceous species in the Sagebrush vegetation type exceeded that encountered in the Pinyon-Juniper type, with

TABLE 3-5. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

REPORT YEAR=1982
GROWTH FORM=FORB
AREA= 5
VEGETATION TYPE=PINYON JUNIPER

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| AGOSERIS GLAUCA | 0.07 | 0.00 - 0.20 |
| ARABIS DIVARICARPA | 0.14 | 0.05 - 0.25 |
| ASTRAGALUS DIVERSIFOLIUS | 0.02 | 0.00 - 0.05 |
| ASTRAGALUS PURSHII | 0.04 | 0.00 - 0.10 |
| BALSAMORHIZA SAGITTATA | 1.03 | 0.00 - 3.70 |
| COMANDRA UMBELLATA | 0.11 | 0.00 - 0.35 |
| CREPIS OCCIDENTALIS | 0.04 | 0.00 - 0.10 |
| CRYPTANTHA SERICEA | 1.19 | 0.10 - 2.60 |
| DESCURAINIA RICHARDSONII | 0.16 | 0.00 - 0.55 |
| ERIOGONUM OVALIFOLIUM | 0.07 | 0.00 - 0.30 |
| HETEROTHECA VILLOSA | 0.17 | 0.00 - 0.35 |
| IPOMOPSIS AGGREGATA | 0.01 | 0.00 - 0.05 |
| LAPPULA REDOWSKII | 0.17 | 0.00 - 0.70 |
| OPUNTIA POLYACANTHA | 0.11 | 0.00 - 0.35 |
| PENSTEMON CAESPITOSUS | 0.32 | 0.15 - 0.65 |
| PENSTEMON FREMONTII | 0.02 | 0.00 - 0.10 |
| PHLOX HOODII | 0.42 | 0.10 - 0.85 |
| PHYSARIA FLORIBUNDA | 0.16 | 0.05 - 0.25 |
| SENECIO MULTILOBATUS | 0.14 | 0.00 - 0.35 |
| SPHAERALCEA COCCINEA | 0.18 | 0.00 - 0.60 |
| STREPTANTHUS CORDATUS | 0.04 | 0.00 - 0.15 |
| TOWNSENDIA INCANA | 0.06 | 0.00 - 0.15 |
| TRIFOLIUM GYMNOCARPON | 0.16 | 0.00 - 0.35 |
| UNKNOWN FORB | 0.11 | 0.00 - 0.20 |
| TOTAL COVER= | 4.94 | |

TABLE 3-6. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 5 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=PINYON JUNIPER | |
| AGROPYRON SPECIES | 1.85 | 1.35 - 2.40 |
| BROMUS TECTORUM | 0.04 | 0.00 - 0.15 |
| CAREX SPECIES | 0.02 | 0.00 - 0.05 |
| HORDEUM JUBATUM | 0.34 | 0.10 - 0.60 |
| KOELERIA MACRANTHA | 0.02 | 0.00 - 0.10 |
| ORYZOPSIS HYMENOIDES | 0.66 | 0.20 - 1.40 |
| POA FENDLERIANA | 0.02 | 0.00 - 0.10 |
| POA SPECIES | 4.93 | 1.90 - 8.70 |
| STIPA COMATA | 0.12 | 0.00 - 0.30 |
| | TOTAL COVER= 8 | |

TABLE 3-7. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

REPORT YEAR=1982 AREA= 6
GROWTH FORM=FORB VEGETATION TYPE=PINYON JUNIPER

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| AGOSERIS SPECIES | 0.01 | 0.00 - 0.05 |
| ANTENNARIA SPECIES | 0.01 | 0.00 - 0.05 |
| ARABIS DIVARICARPA | 0.08 | 0.00 - 0.15 |
| ASTRAGALUS DIVERSIFOLIUS | 0.05 | 0.00 - 0.15 |
| ASTER SPECIES | 0.06 | 0.00 - 0.15 |
| BALSAMORHIZA SAGITTATA | 0.37 | 0.00 - 1.50 |
| COMANDRA UMBELLATA | 0.09 | 0.05 - 0.20 |
| CREPIS OCCIDENTALIS | 0.27 | 0.00 - 0.45 |
| CRYPTANTHA SERICEA | 0.91 | 0.30 - 1.95 |
| DESCURAINIA RICHARDSONII | 0.06 | 0.00 - 0.20 |
| ERIOGONUM UMBELLATUM | 0.02 | 0.00 - 0.10 |
| HEDYSARUM BOREALE | 0.1 | 0.00 - 0.30 |
| HETEROTHECA VILLOSA | 0.05 | 0.00 - 0.20 |
| IPOMOPSIS AGGREGATA | 0.1 | 0.00 - 0.20 |
| LAPPULA REDOWSKII | 0.01 | 0.00 - 0.05 |
| LOMATIUM SPECIES | 0.3 | 0.00 - 1.20 |
| LUPINUS ARGENTEUS | 0.62 | 0.00 - 2.25 |
| OPUNTIA POLYACANTHA | 0.23 | 0.00 - 0.60 |
| PENSTEMON FREMONTII | 0.04 | 0.00 - 0.15 |
| PHLOX HOODII | 0.16 | 0.00 - 0.45 |
| PHLOX LONGIFOLIA | 0.15 | 0.00 - 0.35 |
| PHYSARIA FLORIBUNDA | 0.11 | 0.00 - 0.20 |
| SENECIO MULTILOBATUS | 0.01 | 0.00 - 0.05 |
| SENECIO SPECIES | 0.13 | 0.00 - 0.25 |
| SISYMBRIUM LINIFOLIUM | 0.15 | 0.00 - 0.50 |
| SPHAERALCEA COCCINEA | 0.07 | 0.00 - 0.15 |
| TRIFOLIUM GYMNOCARPON | 0.52 | 0.45 - 0.60 |
| UNKNOWN FORB | 0.02 | 0.00 - 0.10 |
| TOTAL COVER= | 4.7 | |

TABLE 3-8. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 6 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=PINYON JUNIPER | |
| AGROPYRON SPECIES | 1.01 | 0.10 - 1.85 |
| BROMUS TECTORUM | 0.16 | 0.00 - 0.40 |
| CAREX SPECIES | 0.11 | 0.00 - 0.25 |
| KOELERIA MACRANTHA | 0.35 | 0.00 - 1.50 |
| ORYZOPSIS HYMENOIDES | 0.44 | 0.30 - 0.65 |
| POA CANBYI | 0.27 | 0.00 - 0.70 |
| POA FENDLERIANA | 1.38 | 0.00 - 4.90 |
| POA SPECIES | 2.55 | 0.50 - 4.65 |
| SITANION HYSTRIX | 0.16 | 0.00 - 0.35 |
| STIPA COMATA | 0.19 | 0.00 - 0.45 |
| | TOTAL COVER= 6.62 | |

TABLE 3-9. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

REPORT YEAR=1982 AREA= 7
GROWTH FORM=FORB VEGETATION TYPE=PINYON JUNIPER

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| ANTENNARIA MICROPHYLLA | 0.08 | 0.00 - 0.35 |
| ANTENNARIA SPECIES | 0.07 | 0.00 - 0.20 |
| ARABIS DIVARICARPA | 0.05 | 0.00 - 0.15 |
| ARENARIA FENDLERI | 0.07 | 0.00 - 0.20 |
| ASTRAGALUS DIVERSIFOLIUS | 0.06 | 0.00 - 0.10 |
| ASTRAGALUS PURSHII | 0.11 | 0.00 - 0.20 |
| ASTRAGALUS SPATULATUS | 0.21 | 0.00 - 1.00 |
| ASTER SPECIES | 0.01 | 0.00 - 0.05 |
| CHAMAESYCE FENDLERI | 0.11 | 0.00 - 0.55 |
| CHENOPODIUM SPECIES | 0.02 | 0.00 - 0.10 |
| CRYPTANTHA SERICEA | 0.92 | 0.35 - 2.00 |
| DESCURAINIA RICHARDSONII | 0.18 | 0.00 - 0.60 |
| ERIGERON EATONII | 0.04 | 0.00 - 0.20 |
| ERIOGONUM OVALIFOLIUM | 0.01 | 0.00 - 0.05 |
| ERIGERON SPECIES | 0.01 | 0.00 - 0.05 |
| HAPLOPAPPUS ACAULIS | 0.16 | 0.00 - 0.70 |
| HAPLOPAPPUS NUTTALLII | 0.23 | 0.00 - 0.45 |
| HETEROTHECA VILLOSA | 0.01 | 0.00 - 0.05 |
| IPOMOPSIS AGGREGATA | 0.02 | 0.00 - 0.05 |
| IPOMOPSIS CONGESTA | 0.04 | 0.00 - 0.20 |
| LAPPULA REDOWSKII | 0.39 | 0.00 - 1.75 |
| LEPTODACTYLON PUNGENS | 0.33 | 0.00 - 0.70 |
| OPUNTIA POLYACANTHA | 0.01 | 0.00 - 0.05 |
| PHLOX HOODII | 0.89 | 0.35 - 1.70 |
| PHYSARIA FLORIBUNDA | 0.2 | 0.00 - 0.50 |
| SENECIO MULTILOBATUS | 0.44 | 0.25 - 0.55 |
| SISYMBRIUM LINIFOLIUM | 0.03 | 0.00 - 0.10 |
| SPHAERALCEA COCCINEA | 0.02 | 0.00 - 0.05 |
| TOWNSENDIA INCANA | 0.01 | 0.00 - 0.05 |
| TRIFOLIUM GYMNOCARPON | 0.04 | 0.00 - 0.20 |
| UNKNOWN COMPOSITE | 0.01 | 0.00 - 0.05 |
| UNKNOWN FORB | 0.04 | 0.00 - 0.20 |
| TOTAL COVER= | 4.82 | |

TABLE 3-10. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 7 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=PINYON JUNIPER | |
| AGROPYRON SPECIES | 2.38 | 0.00 - 4.85 |
| AGROPYRON TRACHYCAULUM | 0.66 | 0.00 - 3.30 |
| BROMUS TECTORUM | 0.02 | 0.00 - 0.05 |
| HORDEUM JUBATUM | 0.05 | 0.00 - 0.25 |
| KOELERIA MACRANTHA | 0.46 | 0.00 - 1.25 |
| ORYZOPSIS HYMENOIDES | 1.72 | 0.50 - 2.75 |
| POA CANBYI | 1.31 | 0.10 - 2.70 |
| POA FENDLERIANA | 1.36 | 0.30 - 4.15 |
| POA SPECIES | 2.16 | 0.00 - 5.40 |
| STIPA COMATA | 0.27 | 0.00 - 1.15 |
| TOTAL COVER= | 10.39 | |

Table 3-11. Summary of Two-way Nested ANOVA Results Comparing Arcsine Transformed Cover Estimates for Phytosociological Studies.

| Vegetation Type/ Growth Form | Source of Variation: Area | | Area (Transect) | | Report Year | | Area x Report Yr. | | Area x Report Year (Transect) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | F | PR>F 2/ | F | PR>F 2/ | F | PR>F 2/ | F | PR>F 2/ | F | PR>F 2/ |
| Pinyon-Juniper | | | | | | | | | | |
| Grasses | 2.66 | 0.0732 | 1.27 | 0.2391 | 2.43 | 0.0919 | 0.00 | 1.000 | 0.47 | 0.9278 |
| Forbes | 0.24 | 0.7871 | 1.59 | 0.0916 | 1.38 | 0.2519 | 0.00 | 1.000 | 0.50 | 0.9151 |
| Sagebrush | | | | | | | | | | |
| Grasses | 1.37 | 0.2574 | 0.36 | 0.9767 | 0.38 | 0.6870 | 2.24 | 0.1364 | 0.17 | 0.9992 |
| Forbs | 3.48* | 0.0314 | 0.73 | 0.7245 | 0.85 | 0.4293 | 0.00 | 1.0000 | 0.10 | 1.0000 |

1/ PR>F represents the significance probability ($\alpha$) associated with F.

* Significant at $\alpha = 0.05$

a range of from 30.8 in Area 7 to 41.0 percent in Area 6. Although species richness was great (34-45 species) few species contributed more than 1 percent cover in any of the study areas. Lupine (Lupinus argenteus), northern sweetvetch (Hedysarum boreale) and Hood's phlox (Phlox hoodii) were the most abundant forbs encountered (Tables 3-12, 3-14, 3-16). Cover of grasses generally exceeded that of forbs within the Sagebrush type, but the disparity between growth forms was not as pronounced as in the Pinyon-Juniper type. Grass cover ranged from 19.6 percent in Area 5 to 20.6 percent in Areas 6 and 7. Bluegrass, wheatgrass, June-grass (Koeleria macrantha), Indian ricegrass (Oryzopsis hymenoides), and needle-and-thread (Stipa comata) were the most abundant grass species encountered (Tables 3-13, 3-15, 3-17).

Cover of grasses and forbs varied only slightly from that recorded during the 1980 and 1981 sample periods for the Sagebrush vegetation type. A statistical comparison using a 2-way, nested ANOVA indicated no main or interaction effect differences in cover of grasses, and only one main effect difference for forb cover (Table 3-11). Cover of forbs in "treatment" Area 5 was higher than, though not significantly different from, that of "treatment" Area 7. Forb cover in "control" Area 6 was the highest of the three study areas. Although forb cover in Area 6 was not significantly higher than that of Area 5, it was significantly higher than that recorded in Area 7. These differences are illustrated by Duncan's Multiple Range Test results presented in Appendix 3-1.2.

The differences between areas, as noted for forbs in the Sagebrush vegetation type, result from natural variations within vegetation types rather than from any tract-related impacts. Such differences, as well as those which may occur within areas between 1982 and the time these data may be used for further monitoring, must be taken into account.

TABLE 3-12. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 5 | |
| GROWTH FORM=FORB | VEGETATION TYPE=SAGEBRUSH | |
| AGOSERIS GLAUCA | 0.47 | 0.05 - 0.85 |
| ARABIS DIVARICARPA | 0.14 | 0.00 - 0.35 |
| ASTRAGALUS DIVERSIFOLIUS | 0.19 | 0.00 - 0.45 |
| ASTRAGALUS PURSHII | 0.24 | 0.00 - 0.45 |
| ASTER SPECIES | 0.09 | 0.00 - 0.35 |
| CASTILLEJA CHROMOSA | 0.07 | 0.00 - 0.25 |
| CHAENACTIS DOUGLASII | 0.05 | 0.00 - 0.20 |
| COMANDRA UMBELLATA | 0.04 | 0.00 - 0.15 |
| CREPIS OCCIDENTALIS | 0.11 | 0.00 - 0.30 |
| CRYPTANTHA SERICEA | 0.43 | 0.05 - 1.45 |
| DELPHINIUM NUTTALLIANUM | 0.01 | 0.00 - 0.05 |
| DESCURAINIA RICHARDSONII | 0.14 | 0.00 - 0.25 |
| HEDYSARUM BOREALE | 3 | 0.05 - 9.10 |
| HETEROTHECA VILLOSA | 1.04 | 0.50 - 1.65 |
| HYMENOXYS ACAULIS | 0.08 | 0.00 - 0.35 |
| IPOMOPSIS AGGREGATA | 0.14 | 0.05 - 0.30 |
| LINUM LEWISII | 0.02 | 0.00 - 0.10 |
| LITHOSPERMUM SPECIES | 0.05 | 0.00 - 0.25 |
| LUPINUS ARGENTEUS | 0.46 | 0.00 - 1.20 |
| OPUNTIA POLYACANTHA | 0.03 | 0.00 - 0.15 |
| PENSTEMON CAESPITOSUS | 0.69 | 0.00 - 1.40 |
| PENSTEMON FREMONTII | 0.13 | 0.00 - 0.25 |
| PHLOX HOODII | 3.4 | 2.20 - 5.50 |
| PHLOX LONGIFOLIA | 0.25 | 0.00 - 0.60 |
| PHYSARIA FLORIBUNDA | 0.5 | 0.15 - 1.60 |
| SENECIO MULTILOBATUS | 0.15 | 0.00 - 0.35 |
| SISYMBRIUM LINIFOLIUM | 0.06 | 0.00 - 0.20 |
| SPHAERALCEA COCCINEA | 0.94 | 0.45 - 1.50 |
| TARAXACUM OFFICINALE | 0.03 | 0.00 - 0.15 |
| TOWNSENDIA INCANA | 0.09 | 0.00 - 0.20 |
| TOXICOSCORDION VENENOSUM | 0.01 | 0.00 - 0.05 |
| TRIFOLIUM GYMNOCARPON | 0.93 | 0.60 - 1.50 |
| UNKNOWN COMPOSITE | 0.05 | 0.00 - 0.25 |
| UNKNOWN FORB | 0.13 | 0.00 - 0.45 |
| TOTAL COVER= | 14.16 | |

TABLE 3-13. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 5 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=SAGEBRUSH | |
| AGROPYRON SPECIES | 6.1 | 2.95 - 8.10 |
| BROMUS TECTORUM | 0.16 | 0.00 - 0.55 |
| CAREX SPECIES | 0.04 | 0.00 - 0.10 |
| HORDEUM JUBATUM | 0.39 | 0.00 - 1.05 |
| KOELERIA MACRANTHA | 1.4 | 1.05 - 1.70 |
| ORYZOPSIS HYMENOIDES | 2.25 | 1.10 - 3.05 |
| POA CANBYI | 0.17 | 0.00 - 0.50 |
| POA FENDLERIANA | 0.64 | 0.00 - 2.70 |
| POA SPECIES | 6.39 | 4.55 - 8.70 |
| STIPA COMATA | 2.11 | 0.00 - 5.80 |
| TOTAL COVER= | 19.65 | |

TABLE 3-14. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 6 | |
| GROWTH FORM=FORB | VEGETATION TYPE=SAGEBRUSH | |
| AGOSERIS GLAUCA | 0.5 | 0.00 - 1.40 |
| ANTENNARIA MICROPHYLLA | 0.12 | 0.00 - 0.50 |
| ANTENNARIA SPECIES | 0.02 | 0.00 - 0.10 |
| ARABIS DIVARICARPA | 0.2 | 0.00 - 0.45 |
| ASTRAGALUS DIVERSIFOLIUS | 0.15 | 0.00 - 0.75 |
| ASTRAGALUS PURSHII | 0.44 | 0.10 - 1.15 |
| ASTER SPECIES | 0.07 | 0.00 - 0.20 |
| BALSAMORHIZA SAGITTATA | 0.86 | 0.00 - 3.00 |
| CASTILLEJA CHROMOSA | 0.1 | 0.00 - 0.20 |
| CHAENACTIS DOUGLASII | 0.05 | 0.00 - 0.20 |
| COMANDRA UMBELLATA | 0.69 | 0.15 - 1.80 |
| CREPIS OCCIDENTALIS | 1.64 | 0.60 - 4.05 |
| CRYPTANTHA SERICEA | 1.11 | 0.10 - 2.55 |
| DELPHINIUM NUTTALLIANUM | 0.02 | 0.00 - 0.05 |
| DESCURAINIA RICHARDSONII | 0.01 | 0.00 - 0.05 |
| ERIGERON EATONII | 0.02 | 0.00 - 0.10 |
| ERIGERON SPECIES | 0.03 | 0.00 - 0.15 |
| ERIOGONUM UMBELLATUM | 0.16 | 0.00 - 0.80 |
| ERYSIMUM ASPERUM | 0.03 | 0.00 - 0.15 |
| ERYSIMUM SPECIES | 0.01 | 0.00 - 0.05 |
| HAPLOPAPPUS NUTTALLII | 0.29 | 0.00 - 1.05 |
| HEDYSARUM BOREALE | 2.64 | 0.50 - 4.00 |
| HETEROTHECA VILLOSA | 0.55 | 0.00 - 1.00 |
| HYMENOXYS ACAULIS | 0.17 | 0.00 - 0.80 |
| IPOMOPSIS AGGREGATA | 0.07 | 0.00 - 0.15 |
| LAPPULA REDOWSKII | 0.04 | 0.00 - 0.15 |
| LINUM LEWISII | 0.2 | 0.00 - 0.80 |
| LITHOSPERMUM RUDERALE | 0.1 | 0.00 - 0.50 |
| LOMATIUM SPECIES | 0.07 | 0.00 - 0.20 |
| LUPINUS ARGENTEUS | 4.79 | 0.00 - 11.70 |
| OPUNTIA POLYACANTHA | 0.03 | 0.00 - 0.15 |
| PENSTEMON FREMONTII | 0.15 | 0.00 - 0.30 |
| PHLOX HOODII | 1.01 | 0.30 - 1.80 |
| PHLOX LONGIFOLIA | 0.76 | 0.05 - 1.30 |
| PHYSARIA FLORIBUNDA | 0.25 | 0.00 - 0.90 |
| SENECIO INTEGERRIMUS | 0.22 | 0.00 - 0.95 |
| SENECIO MULTILOBATUS | 0.32 | 0.00 - 0.65 |
| SENECIO SPECIES | 0.02 | 0.00 - 0.10 |
| SISYMBRIUM LINIFOLIUM | 0.02 | 0.00 - 0.10 |
| SPHAERALCEA COCCINEA | 0.72 | 0.05 - 1.55 |
| TOWNSENDIA INCANA | 0.18 | 0.00 - 0.90 |
| TOXICOSCORDION VENENOSUM | 0.15 | 0.00 - 0.40 |
| TRIFOLIUM GYMNOCARPON | 1.26 | 0.55 - 2.30 |
| UNKNOWN COMPOSITE | 0.01 | 0.00 - 0.05 |
| UNKNOWN FORB | 0.33 | 0.00 - 0.60 |
| TOTAL COVER= | 20.58 | |

TABLE 3-15. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 6 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=SAGEBRUSH | |
| AGROPYRON SPECIES | 3.67 | 2.15 - 6.75 |
| BROMUS TECTORUM | 1.11 | 0.05 - 3.00 |
| CAREX SPECIES | 0.56 | 0.00 - 2.75 |
| KOELERIA MACRANTHA | 3.51 | 1.20 - 6.00 |
| ORYZOPSIS HYMENOIDES | 0.22 | 0.00 - 0.45 |
| POA CANBYI | 4.72 | 1.45 - 9.30 |
| POA FENDLERIANA | 0.78 | 0.00 - 3.85 |
| POA SPECIES | 4.17 | 0.15 - 7.35 |
| SITANION HYSTRIX | 0.02 | 0.00 - 0.10 |
| STIPA COMATA | 1.59 | 0.05 - 2.90 |
| TOTAL COVER= | 20.35 | |

TABLE 3-16. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 7 | |
| GROWTH FORM=FORB | VEGETATION TYPE=SAGEBRUSH | |
| AGOSERIS SPECIES | 0.01 | 0.00 - 0.05 |
| ANTENNARIA MICROPHYLLA | 0.01 | 0.00 - 0.05 |
| ARABIS DIVARICARPA | 0.02 | 0.00 - 0.10 |
| ARENARIA FENDLERI | 0.01 | 0.00 - 0.05 |
| ASTRAGALUS DIVERSIFOLIUS | 0.27 | 0.00 - 0.75 |
| ASTRAGALUS PURSHII | 0.42 | 0.15 - 0.70 |
| ASTRAGALUS SPATULATUS | 0.14 | 0.00 - 0.45 |
| ASTER SPECIES | 0.02 | 0.00 - 0.10 |
| CASTILLEJA CHROMOSA | 0.21 | 0.00 - 0.75 |
| CREPIS OCCIDENTALIS | 0.25 | 0.00 - 0.95 |
| CREPIS SPECIES | 0.01 | 0.00 - 0.05 |
| CRYPTANTHA SERICEA | 0.83 | 0.25 - 1.70 |
| DELPHINIUM NUTTALLIANUM | 0.02 | 0.00 - 0.05 |
| ERIGERON EATONII | 0.18 | 0.00 - 0.90 |
| ERIOGONUM OVALIFOLIUM | 0.14 | 0.00 - 0.70 |
| HAPLOPAPPUS ACAULIS | 0.01 | 0.00 - 0.05 |
| HAPLOPAPPUS NUTTALLII | 0.39 | 0.00 - 1.70 |
| HEDYSARUM BOREALE | 0.65 | 0.00 - 2.60 |
| HETEROTHECA VILLOSA | 0.82 | 0.00 - 1.60 |
| IPOMOPSIS AGGREGATA | 0.01 | 0.00 - 0.05 |
| IPOMOPSIS CONGESTA | 0.12 | 0.00 - 0.60 |
| LAPPULA REDOWSKII | 0.03 | 0.00 - 0.10 |
| LINUM LEWISII | 0.47 | 0.00 - 2.15 |
| LOMATIUM SPECIES | 0.03 | 0.00 - 0.15 |
| OPUNTIA POLYACANTHA | 0.15 | 0.00 - 0.70 |
| PENSTEMON FREMONTII | 0.33 | 0.00 - 0.70 |
| PHLOX HOODII | 2.98 | 1.30 - 4.70 |
| PHLOX LONGIFOLIA | 0.34 | 0.00 - 1.70 |
| PHYSARIA FLORIBUNDA | 0.14 | 0.00 - 0.50 |
| SENECIO MULTILOBATUS | 0.22 | 0.00 - 0.90 |
| SISYMBRIUM LINIFOLIUM | 0.08 | 0.00 - 0.25 |
| SPHAERALCEA COCCINEA | 0.52 | 0.05 - 0.80 |
| TOWNSENDIA INCANA | 0.1 | 0.00 - 0.25 |
| TOXICOSCORDION VENENOSUM | 0.02 | 0.00 - 0.05 |
| TRIFOLIUM GYMNOCARPON | 0.2 | 0.00 - 0.65 |
| UNKNOWN COMPOSITE | 0.02 | 0.00 - 0.10 |
| UNKNOWN FORB | 0.02 | 0.00 - 0.10 |
| TOTAL COVER= | 10.19 | |

TABLE 3-17. PERCENT COVER OF HERBACEOUS SPECIES FOUND ON TRANSECTS SAMPLED IN THE PHYTOSOCIOLOGICAL STUDIES PROGRAM

| SPECIES | AVERAGE COVER (%) | RANGE (%) |
|---|---|---|
| REPORT YEAR=1982 | AREA= 7 | |
| GROWTH FORM=GRASS | VEGETATION TYPE=SAGEBRUSH | |
| AGROPYRON SPECIES | 3.08 | 1.00 - 4.70 |
| CAREX SPECIES | 0.59 | 0.00 - 2.90 |
| HORDEUM JUBATUM | 0.12 | 0.00 - 0.50 |
| KOELERIA MACRANTHA | 3.24 | 2.45 - 4.75 |
| ORYZOPSIS HYMENOIDES | 1.73 | 0.50 - 3.45 |
| POA CANBYI | 2.21 | 0.30 - 6.15 |
| POA FENDLERIANA | 2.56 | 0.00 - 4.95 |
| POA SPECIES | 1.26 | 0.00 - 3.25 |
| STIPA COMATA | 5.77 | 4.10 - 7.75 |
| TOTAL COVER= | 20.56 | |

D. Range Productivity and Utilization

1. Objectives

Tract C-a MDP activities may affect range conditions on and near the tract by altering the use patterns of deer, cattle, and feral horse populations, thus changing the grazing pressure. The range studies are designed to provide information which can be used to compare range productivity and utilization before and during modular development. Because activities associated with tract development are confined primarily to the mine process area, impacts on range conditions are projected to be localized. Therefore, range studies focus on areas of Tract C-a and vicinity that are adjacent to MDP activities, and that were used for grazing prior to MDP activities.

2. Methods

The methods followed for collection of range data were described in MDP Monitoring Reports 1, 2, 3, 4 and 5 (RBOSC 1978a, 1978b, 1979a, 1979b, 1980).

The range productivity data are analyzed by the following two-way ANOVA to compare pre-development conditions with those during development. By segregating data by vegetation type, as well as by caged vs. uncaged sample plots, one is able to assess differences in production and use at various sample sites within each vegetation type as a whole.

| Source of Variation | Degrees of Freedom | F-Ratio | Expected Mean Squares |
|---|---|---|---|
| A. Years | a-1 | A/D | $\sigma^2 + \frac{nb}{a-1}\sum^{a}\alpha^2$ |
| B. Transects | b-1 | B/D | $\sigma^2 + \frac{na}{b-1}\sum^{b}\beta^2$ |
| C. Year x Transects | (a-1)(b-1) | C/D | $\sigma^2 + \frac{n}{(a-1)(b-2)}\sum^{ab}(\alpha\beta)^2$ |
| D. Error | ab(n-1) | | $\sigma^2$ |
| TOTAL | (abn)-1 | | |

This two-way, fixed effects model ANOVA is used to detect differences in primary productivity for a given vegetation type between years (main effect A) and between transects within a given vegetation type (main effect B). The interaction term tests for differences between years by transect (C).

In addition, the following one-way, fixed effects model ANOVA is used to test for variability between production on transects in a given vegetation type for each sample period (year). These data are also segregated by plot type (caged vs. uncaged) before analysis so that the impacts of grazing are not masked by lumping both protected (caged) and unprotected (uncaged) sample locations.

| Source of Variation | Degrees of Freedom | F-Ratio | Expected Mean Squares |
|---|---|---|---|
| A. Transect | a-1 | A/B | $\sigma^2 + \frac{n}{a-1}\sum^{a}\alpha^2$ |
| B. Error | ab(n-1) | | $\sigma^2$ |
| TOTAL | na-1 | | |

## 3. Results and Discussion

Production data are summarized in Table 3-18 and are presented in their entirety in Appendix 3-1.3.

a. Mixed Brush - Mean production of herbaceous species during the 1982 season was 415.6 kg/ha within protected (caged) sample plots and 376.3 kg/ha for uncaged plots (those available for grazing) (Table 3-18). Forb production exceeded that for grasses in both caged and uncaged plots, accounting for 55 and 58 percent of the total production on the respective plots. Wheatgrasses, Indian ricegrass, June-grass, and bluegrass species were the most prominent grasses, comprising 95 percent of the total production. Species richness for forbs far exceeded that for grasses; nevertheless, six species contributed approximately 70 percent forb production. In large part, these were the same species encountered most

TABLE 3-18. RANGE PRODUCTION (STANDING CROP, DRY WEIGHT, KG/HA) OF SPECIES ENCOUNTERED IN CAGED AND UNCAGED PLOTS WITHIN THREE VEGETATION TYPES IN THE VICINITY OF TRACT C-A DURING 1982.

| SPECIES | MIXED BRUSH | | PINYON-JUNIPER | | SAGEBRUSH | |
|---|---|---|---|---|---|---|
| | CAGED | UNCAGED | CAGED | UNCAGED | CAGED | UNCAGED |
| NO. OF PLOTS | 44 | 46 | 80 | 80 | 75 | 75 |
| FORB | | | | | | |
| ACHILLEA LANULOSA | 0.29 | 0.16 | • | • | • | • |
| AGROPYRON SPECIES | • | • | • | • | • | 0.01 |
| ARENARIA FENDLERI | • | • | 0.23 | 0.67 | • | • |
| ASTRAGALUS DIVERSIFOLIUS | 5.71 | 3.62 | 0.01 | 0.14 | 1.89 | 2.40 |
| ASTRAGALUS PURSHII | 2.91 | 3.64 | 0.54 | 0.28 | 0.21 | 0.30 |
| ASTRAGALUS SPATULATUS | • | • | 0.01 | • | • | 0.48 |
| ASTER SPECIES | • | • | • | 0.05 | • | 0.26 |
| BALSAMORHIZA SAGITTATA | 0.67 | 4.38 | • | 13.26 | 4.10 | • |
| CAREX SPECIES | • | 0.02 | • | 0.01 | • | • |
| CHAENACTIS DOUGLASII | 0.02 | 0.98 | • | • | 0.23 | • |
| CHAMAESYCE FENDLERI | • | • | 0.39 | 0.14 | • | • |
| CHENOPODIUM SPECIES | • | • | • | 0.01 | • | • |
| COMANDRA UMBELLATA | 31.64 | 18.02 | 3.39 | 1.57 | 3.27 | 8.64 |
| CREPIS OCCIDENTALIS | 3.00 | 0.24 | 0.04 | • | 1.29 | 1.69 |
| CRUCIFERAE SPECIES | 2.76 | 0.91 | 0.80 | 0.16 | 0.48 | 0.31 |
| CRYPTANTHA SERICEA | 8.96 | 9.89 | 6.23 | 13.28 | 4.03 | 3.14 |
| ERIGERON EATONII | 6.49 | 7.40 | 0.06 | 0.09 | 1.99 | 1.39 |
| ERIOGONUM LONCHOPHYLLUM | 0.09 | 1.82 | 0.37 | 0.20 | • | 0.01 |
| ERIOGONUM UMBELLATUM | 32.20 | 47.04 | 0.06 | • | • | 0.04 |
| HAPLOPAPPUS ACAULIS | 0.07 | • | 0.52 | • | 0.58 | 0.43 |
| HAPLOPAPPUS NUTTALLII | 5.60 | 4.02 | 3.04 | 4.63 | 1.45 | 2.00 |
| HEDYSARUM BOREALE | 47.31 | 36.78 | • | • | 9.01 | 6.06 |
| IPOMOPSIS AGGREGATA | 6.33 | 2.71 | 0.35 | 0.38 | 1.75 | 0.92 |
| KOELERIA MACRANTHA | • | • | • | • | 0.29 | 0.08 |
| LAPPULA REDOWSKII | • | • | 0.04 | 0.05 | • | • |
| LEPTODACTYLON PUNGENS | • | • | 0.52 | 0.38 | • | • |
| LINUM LEWISII | 5.71 | 4.24 | • | 0.02 | 1.36 | 0.01 |
| LITHOSPERMUM SPECIES | 7.33 | • | • | • | • | • |
| LUPINUS ARGENTEUS | 13.42 | 9.53 | 0.19 | 0.01 | 0.81 | 7.35 |
| LUPINUS SPECIES | • | • | 0.09 | • | 3.71 | 4.12 |
| MACHAERANTHERA PATTERSONII | 0.56 | 0.27 | 1.38 | 0.26 | 0.01 | 0.01 |
| PENSTEMON CAESPITOSUS | 7.67 | 4.38 | • | • | • | 0.38 |
| PENSTEMON SPECIES | 0.31 | 1.29 | 0.14 | 0.41 | 0.26 | 0.36 |
| PHLOX HOODII | 7.93 | 27.07 | 28.05 | 12.94 | 61.60 | 73.42 |
| PHLOX LONGIFOLIA | • | • | 0.03 | • | 0.23 | 0.25 |
| PHYSARIA FLORIBUNDA | 4.20 | 2.91 | 1.05 | 1.57 | 0.08 | 0.53 |
| POA SPECIES | • | • | 1.30 | • | • | 0.21 |
| SALSOLA KALI | • | • | 0.01 | • | • | • |
| SENECIO MULTILOBATUS | 0.89 | 0.02 | 1.48 | 0.65 | 0.84 | 1.45 |
| SPHAERALCEA COCCINEA | 2.02 | 2.02 | 0.16 | 0.14 | 3.12 | 3.32 |
| TARAXACUM OFFICINALE | • | 0.42 | 0.11 | 0.01 | • | • |
| TOWNSENDIA INCANA | 22.80 | 22.27 | 1.71 | 2.37 | 3.18 | 4.82 |
| TRIFOLIUM GYMNOCARPON | • | • | • | • | 0.01 | 0.01 |
| UNKNOWN FORB | 3.69 | 3.80 | 0.13 | 0.19 | 2.89 | 3.64 |
| SUBTOTALS | 230.6 | 219.9 | 52.4 | 53.9 | 108.7 | 128.1 |
| GRASS | | | | | | |
| AGROPYRON SPECIES | 80.09 | 66.60 | 16.38 | 12.60 | 73.95 | 40.71 |
| BROMUS TECTORUM | 0.22 | • | 1.27 | 0.04 | 20.67 | 25.22 |
| CAREX SPECIES | 1.96 | 3.91 | 4.10 | 3.00 | 3.16 | 4.08 |
| CRUCIFERAE SPECIES | • | • | • | • | 0.07 | • |
| ELYMUS CINEREUS | • | • | • | • | • | 5.88 |
| KOELERIA MACRANTHA | 24.80 | 20.07 | 3.04 | 1.22 | 18.32 | 20.61 |
| ORYZOPSIS HYMENOIDES | 43.56 | 40.24 | 10.23 | 12.22 | 23.03 | 16.47 |
| PHYSARIA FLORIBUNDA | • | 0.13 | • | • | • | • |
| POA SPECIES | 28.49 | 20.89 | 23.57 | 17.67 | 21.11 | 20.53 |
| SITANION HYSTRIX | 0.82 | 0.11 | 1.43 | 0.64 | 5.97 | 3.55 |
| STIPA COMATA | 5.07 | 4.49 | 6.37 | 2.78 | 45.62 | 47.88 |
| SUBTOTALS | 185.0 | 156.4 | 66.4 | 50.2 | 211.9 | 184.9 |
| TOTAL GRASS AND FORBS (KG/HA) | 415.6 | 376.3 | 118.8 | 104.0 | 320.6 | 313.0 |

frequently during the phytosociological studies: bastard toadflax (Comandra umbellata), sulfur eriogonum (Eriogonum umbellatum), northern sweetvetch, lupine, Hood's phlox, and hoary townsendia (Townsendia incana).

Production in protected plots for 1982 has declined relative to 1981 but remained considerably higher than for the 1978-1980 period (Table 3-19). The standing crop in unprotected plots, which are susceptible to grazing, increased relative to 1981. These data seem to indicate that grazing pressure by livestock during 1982 was lower than for the previous year. Comparisons between years indicated that utilization has decreased from the high of 31 percent recorded for the Mixed Brush vegetation type in 1980 to 10 percent in 1982 (Table 3-19).

When production data for both caged and uncaged plots were analyzed using a three-way ANOVA, significant main effect differences among years and among transects were evident for uncaged plots but not for caged plots (Table 3-20). It is unclear why significant differences are not indicated for caged plots based on the apparent large differences in production noted among years. Those differences noted for uncaged plots may be related, in part, to variations in grazing pressure, as well as natural variations resulting from site locations within the vegetation type. For the most part, differences in production among individual transects were not significant; nevertheless, several groupings of transects were evident for uncaged plots (Appendix 3-1.4). The standing crop of grasses during 1982 was shown to be significantly higher for uncaged plots than that recorded in 1978 (Appendix 3-1.4). The differences noted for forbs, however, were not significant at the five percent level.

In order to ascertain the status of 1982 data without the influence of previous years, an one-way ANOVA comparing production of grasses and forbs was run for 1982 alone. No significant differences were noted for either caged or uncaged plots among the nine Mixed Brush transects (Table 3-21). Consequently, it is apparent that variations in production of grasses and forbs were more prevalent in previous years. Similar results were noted for 1981 data; therefore, one can assume that variations being identified in the three-way ANOVA resulted from 1978-1980 data.

Table 3-19. Comparison of Range Production (standing crop, dry weight, kg/ha) and Utilization (%) Estimates on and Near Tract C-a, 1978 through 1982

| | Standing Crop | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Caged Plots (dry wt, kg/ha) | | | | | Uncaged Plots (dry wt, kg/ha) | | | | | Utilization (Percent) | | | | |
| Vegetation Type | 1978 | 1979 | 1980 | 1981 | 1982 | 1978 | 1979 | 1980 | 1981 | 1982 | 1978 | 1979 | 1980 | 1981 | 1982 |
| Mixed Brush (N)[1/] | (50) | (50) | (49) | (45) | (44) | (50) | (50) | (50) | (45) | (46) | | | | | |
| Grasses | 99 | 140 | 159 | 194 | 185 | 69 | 85 | 111 | 140 | 156 | 30 | 39 | 30 | 28 | 16 |
| Forbs | 111 | 104 | 132 | 247 | 231 | 77 | 88 | 91 | 203 | 220 | 31 | 15 | 31 | 18 | 5 |
| Total | 210 | 244 | 291 | 441 | 416 | 146 | 173 | 202 | 343 | 376 | 30 | 29 | 31 | 22 | 10 |
| Pinyon-Juniper (N)[1/] | (50) | (49) | (50) | (79) | (80) | (50) | (46) | (50) | (81) | (80) | | | | | |
| Grasses | 26 | 34 | 43 | 60 | 66 | 13 | 26 | 36 | 46 | 50 | 50 | 24 | 16 | 23 | 24 |
| Forbs | 18 | 18 | 30 | 46 | 52 | 10 | 18 | 30 | 69 | 54 | 44 | 0 | 0 | ...[2/] | ...[2/] |
| Total | 44 | 52 | 73 | 106 | 119 | 23 | 44 | 66 | 115 | 104 | 48 | 15 | 10 | ...[2/] | 13 |
| Upland Sagebrush (N)[1/] | (50) | (50) | (49) | (73) | (75) | (50) | (48) | (50) | (77) | (75) | | | | | |
| Grasses | 85 | 132 | 157 | 216 | 212 | 51 | 78 | 94 | 141 | 185 | 40 | 41 | 40 | 35 | 13 |
| Forbs | 40 | 42 | 62 | 219 | 109 | 29 | 29 | 37 | 155 | 128 | 28 | 31 | 40 | 29 | ...[2/] |
| Total | 125 | 174 | 219 | 435 | 321 | 80 | 107 | 131 | 296 | 313 | 36 | 39 | 40 | 32 | 2 |

1/ Differences in the number of plots sampled (N) result when caged plots have been disturbed and do not function as protected sampling locations.

2/ Higher production recorded in uncaged as compared to caged plots; thus, no utilization has been calculated.

Table 3-20. Summary of Two-Way ANOVA Results Comparing Range Productivity for 1978 through 1982, Tract C-a[1/]

| Vegetation Type | Source of Variation: Years F | Years PR>F [2/] | Transects F | Transects PR>F [2/] | Year x Transect F | Year x Transect PR>F [2/] |
|---|---|---|---|---|---|---|
| **Plot Type - Caged** | | | | | | |
| Mixed Brush | | | | | | |
| Grasses | 1.83 | 0.1222 | 1.26 | 0.2631 | 0.62 | 0.9490 |
| Forbs | 1.45 | 0.2150 | 1.49 | 0.1559 | 0.83 | 0.7369 |
| Pinyon-Juniper | | | | | | |
| Grasses | 4.91** | 0.0007 | 1.75* | 0.0355 | 1.12 | 0.2762 |
| Forbs | 1.09 | 0.3631 | 3.12** | 0.0001 | 1.76** | 0.0030 |
| Sagebrush | | | | | | |
| Grasses | 3.79** | 0.0046 | 8.08** | 0.0001 | 1.04 | 0.4044 |
| Forbs | 4.92** | 0.0007 | 6.24** | 0.0001 | 1.35 | 0.0866 |
| **Plot Type - Uncaged** | | | | | | |
| Mixed Brush | | | | | | |
| Grasses | 4.06** | 0.0030 | 2.87** | 0.0040 | 0.90 | 0.6333 |
| Forbs | 1.75 | 0.1362 | 2.15* | 0.0294 | 0.71 | 0.8826 |
| Pinyon-Juniper | | | | | | |
| Grasses | 6.39** | 0.0001 | 1.61 | 0.0622 | 1.30 | 0.0996 |
| Forbs | 1.05 | 0.3794 | 1.47 | 0.1079 | 0.97 | 0.5334 |
| Sagebrush | | | | | | |
| Grasses | 9.40** | 0.0001 | 3.19** | 0.0001 | 1.42* | 0.0464 |
| Forbs | 4.26** | 0.0021 | 2.00** | 0.0162 | 1.53* | 0.0288 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test Results for significant main effects are presented in Appendix 3-1.4.

2/ PR>F represents the significance probability ($\alpha$) associated with F.

Table 3-21. Summary of One-way ANOVA Results Comparing Range Productivity Among Transects by Vegetation Type for 1982, Tract C-a[1/]

| Vegetation Type | Caged | | Uncaged | |
|---|---|---|---|---|
| | F | PR>F [2/] | F | PR>F [2/] |
| Mixed Brush | | | | |
| Grasses | 0.49 | 0.8645 | 0.79 | 0.6138 |
| Forbs | 1.48 | 0.1631 | 1.34 | 0.2236 |
| Pinyon-Juniper | | | | |
| Grasses | 0.91 | 0.5507 | 1.62 | 0.0749 |
| Forbs | 1.05 | 0.4043 | 1.92* | 0.0254 |
| Sagebrush | | | | |
| Grasses | 3.78** | 0.0001 | 2.54** | 0.0022 |
| Forbs | 1.74 | 0.0687 | 1.67 | 0.0755 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 3-1.4.

2/ PR>F represents the significance probability ($\alpha$) associated with F.

It does not appear that development activities are influencing the use of the Mixed Brush range on or adjacent to Tract C-a. If tract development was the only factor influential to range use, one would expect an increase in grazing pressure to correspond to the curtailed pace of development from 1980-1982. This was not the case, however. It is more probable that variations in range utilization are related to rotations on grazing allotments or to reductions in the feral horse populations, both of which are controlled by the BLM.

b. Pinyon-Juniper - Mean production of herbaceous species ranged from 118.8 kg/ha in caged plots to 104.0 kg/ha in uncaged plots within the Pinyon-Juniper vegetation type (Table 3-18). Although species richness for forbs exceeded that of grasses, the grasses accounted for a greater proportion of total standing crop than was noted in the Mixed Brush type (56 and 48 percent for caged and uncaged plots, respectively). Aside from June-grass which was present in considerably lower quantities, the prominent grasses in the Pinyon-Juniper type were the same as those of the Mixed Brush type. Bastard toadflax and Hood's phlox were important forbs common to both types but several other species, including Cryptantha sericea, goldenweed (Haplopappus nuttallii), and arrowleaf balsam-root (Balsamorhiza sagittata), were of increased importance within the Pinyon-Juniper type.

Production within caged plots during 1982 (119 kg/ha) was the highest recorded during five years of study (Table 3-19). The standing crop recorded for unprotected sample plots decreased slightly from the high encountered for 1981 (104 vs 115 kg/ha). Utilization of herbaceous species within the Pinyon-Juniper type was 13 percent during 1982, which was similar to that recorded during 1979 and 1980. Because the standing crop for forbs continues to be higher in uncaged than in caged plots, the entire utilization, as calculated for these studies, can be attributed to the consumption of grasses. If grasses alone are considered, use within the Pinyon-Juniper type would be 24 percent.

Comparisons of 1982 data with those from previous years using a three-way ANOVA indicated that significant differences among years and among transects exist for production both on caged and uncaged plots (Table 3-20). Production of grasses within caged plots during 1982 was similar to that recorded during 1981 and 1979, but significantly higher than production during 1980 and 1978 (Appendix 3-1.4). Although forb production among most transects was not significantly different, Transects 37, 43 and 46 had significantly higher standing crop than on 11 of the remaining 14 transects (Appendix 3-1.4). Production of grass species within caged plots was significantly higher on Transect 46 than on 10 of the 16 other Pinyon-Juniper transects.

Differences in standing crop on uncaged plots were less evident than for caged sites. The three-way ANOVA results indicated that the only significant differences were among years for grass species (Table 3-20). In this instance, the standing crop of grasses for 1982 was similar to that recorded during 1980 and 1981, but significantly higher than for 1978 and 1979 (Appendix 3-1.4). One would expect that significant differences among years for uncaged plots indicate variations in grazing pressure: in this case, decreased grazing pressure in 1982 relative to 1978 and 1979. This may be related in part to rotations on grazing allotments in the area, as well as reductions in the size of the feral horse herds. In addition, increased standing crop of grasses in uncaged plots corresponds to a similar increase in caged plots. This suggests that, regardless of grazing pressure, natural variations in the region have resulted in increased production over the past several years. As noted during 1981, this may be related in increased precipitation (RBOSC 1982a).

In order to examine only the 1982 data, production for caged and uncaged plots among the various transects was compared using an one-way ANOVA (Table 3-21). Variations noted for production of grasses and forbs on caged plots in the three-way ANOVA were not evident in the 1982 data. Therefore, differences evidenced via the three-way ANOVA seem to be the result of 1978-1981 data. However, differences in production of forbs on uncaged plots appeared to be variable among transects for 1982, whereas no

differences were indicated when all years were compared. The standing crop of forbs was significantly higher on Transect 36 than on 15 of the remaining 16 transects (Appendix 3-1.4). Inspection of field data indicated that the occurrence of arrowleaf balsam-root along Transect 36 may have been an important factor contributory to this difference among Pinyon-Juniper transects for 1982.

c. Sagebrush - Production within the Sagebrush vegetation type was intermediate to that of Mixed Brush and Pinyon-Juniper types. Total production in caged plots was 320.6 kg/ha whereas standing crop in uncaged plots averaged 313.0 kg/ha (Table 3-18). Grass species accounted for the majority production, contributing 211.9 and 184.9 kg/ha in caged and uncaged plots respectively. Production of forbs averaged 108.7 kg/ha in caged plots and 128.1 kg/ha in unprotected plots. Important grass species were similar to those encountered in the Mixed Brush type; however, cheatgrass (Bromus tectorum) and needle-and-thread (Stipa comata) contributed considerably more production within the Sagebrush type than either of the other two types sampled. It should be noted that cheatgrass is an indicator of overgrazed range. Forbs generally were similar to those encountered in the Mixed Brush type. Hood's phlox was by far the most abundant species, accounting for 57 percent of forb production.

Production during 1982 within caged plots decreased relative to 1981 values (Table 3-19). The vast majority of the decrease was accounted for by reduction in forb standing crop. Forbs within uncaged plots also showed a decrease for 1982; however, increased grass production more than offset this reduction so that total production with uncaged plots actually increased. As with forbs in the Pinyon-Juniper type, standing crop within uncaged plots exceeded that of caged plots. Consequently, utilization could not be determined. Use of grasses appeared to have declined markedly, from 35 percent in 1981 to 13 percent in 1982. It is unclear whether these data represent actual changes in grazing pressure or if they result, in part, from the study design. The apparent reduction in grazing pressure within the Sagebrush type exceeded the 50 percent reduction noted for the Mixed Brush type.

Results of three-way ANOVA's for production within caged and uncaged plots of the Sagebrush vegetation type indicated that main effect differences exist for both grasses and forbs (Table 3-20). Duncan's Multiple Range Test results indicated that grass production within caged plots was similar for all years except 1978, which had lower production (Appendix 3-1.4). For forb species, the 1982 data were similar to all other sample periods except 1981, which exhibited significantly higher production. Furthermore, production of forbs was shown to be significantly higher on Transects 41 and 45 than on 12 of the 13 remaining transects. Transects 15 and 28, two bottomland sites, consistently have higher production of grasses than the other transects. A substantial portion of this production resulted from cheatgrass, a species indicative of overgrazed sites. Although groupings were somewhat more complex, the trends among years for grasses and forbs on unprotected plots generally mirrored those for caged plots (Appendix 3-1.4).

When 1982 data were considered alone, one-way ANOVA results indicated significant differences in grass production among transects (Table 3-21). The ordering of transects as based on production of grasses within caged plots was similar to that exhibited via Duncan's Multiple Range Tests for significant differences as indicated in the two-way ANOVA (Appendix 3-1.4). The variations in transect groupings noted for uncaged plots may reflect differences in grazing pressure. In several instances, however, production on uncaged plots exceeded that of caged plots on the same transect. These inconsistencies in the data are artifacts of the study design and illustrate that the vegetation cover is a mosaic. If a greater proportion of caged than uncaged plots happen to fall within openings in the vegetation, production in uncaged plots exceeds that of protected sites regardless of grazing pressure. Data for forbs in both caged and uncaged plots were not significantly different at the five percent level (Table 3-21). This indicates that the variability in forb production, as noted in the two-way ANOVA results, was greater in previous years than in 1982.

## 3.2 FAUNA

### A. Mule Deer Density

#### 1. Objectives

Mule deer (Odocoileus hemionus) is the most important game species in Colorado in terms of recreational use and money expended by hunters. The Piceance Creek Basin is the wintering area of one of the largest migratory mule deer herds in the U.S. Tract C-a is within the Piceance Creek Basin which, for the most part, corresponds to the Colorado Division of Wildlife's Game Management Unit 22.

Moderate to high numbers of mule deer occur on and in the vicinity of Tract C-a during the winter and migration periods. Deer are uncommon around Tract C-a during the summer.

Consideration of the possible effects of Tract C-a development on mule deer is an integral part of RBOSC's Fish and Wildlife Management Plan. The objectives of RBOSC's mule deer monitoring program are to obtain indices of mule deer density in a 9 x 9 mile (81 sq. mi) study area centered on Tract C-a (the tract and a 3-mile buffer zone), to compare indices of mule deer density from the study area with those from Game Management Unit 22 and, if possible, to compare differences in mule deer densities within various portions of the study area.

#### 2. Methods

Mule deer densities can be estimated from pellet group density data because mule deer daily defecation rates are reasonably uniform (Neff 1968). The number of pellet groups per unit area, days of use by deer, and deer per unit area in the RBOSC study area are determined as described by Overton (1971). The methods followed for collection and analysis of these data are described in RBOSC MDP Monitoring Report 1 (RBOSC 1978a).

Mule deer pellet groups have been counted every spring and fall since 1978. The RBOSC mule deer study area is composed of nine blocks, each 9 square miles in extent. Within each block are seven quarter-section sampling units, which were randomly selected during the design of the study. Pellet counts are made on 20 permanent plots within each of these 63 quarter-section sampling units, for a total of 1260 plots.

## 3. Results and Discussion

Mule deer winter density estimates for the MDP monitoring period, based on pellet group counts, are presented in Table 3-22. The table shows that the mule deer density during the winter of 1981-82 ranged from 12 to 56 mule deer per square mile ($mi^2$) among the 9 blocks of the study area, with an average of 32 deer/$mi^2$. Detailed data on each plot and pellet group counts for the September 1982 sampling period are presented in Appendix 3-2.1. Duncan's Multiple Range Test results on all winter pellet group data collected to date are also presented in Appendix 3-2.2.

The migratory and nomadic nature of mule deer make determining a true density in any one area difficult. These data in Table 3-22 represent only an average number of "deer-use" days during the respective winters. For example, a number of pellet groups could indicate one deer in an area for ten days or ten deer in an area for one day.

The Colorado Division of Wildlife (DOW) counts deer from an aircraft each winter. The estimated number of deer per square mile of "winter range" in Game Management Unit 22 for each winter of the MDP monitoring period are presented in Table 3-22 for comparison purposes. The average density estimate for 1981-82 of 32 deer/$mi^2$ in the RBOSC study area, based on pellet group counts, is identical to the deer density obtained by the actual 1981-82 aerial count by the DOW.

The density estimates presented in Table 3-22 indicate a slow increase in deer numbers following the severe winter die back expressed in the 1979-80 estimate. Although the 1981-82 estimate of 32 deer/$mi^2$ is slightly higher

Table 3-22. Estimated Number of Mule Deer Per Square Mile by Block of the RBOSC Study Area for Winter Periods 1977-1982 And Basic Habitat Type Descriptors by Block.

| | Estimated Number of Deer Per Square Mile[1/] | | | | | | Habitat Type Descriptors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter Period[2/] | | | | | | Mean | Mean[3/] | Mean[4/] | Vegetation Type[5/] By Percent | | | | | |
| Block | 77-78 | 78-79 | 79-80 | 80-81 | 81-82 | Avg. | Elevation | Slope | Aspect | MB | SB | PJ | MP | SP | OT |
| 1 | 63 | 62 | 32 | 56 | 52 | 53.0 | 7300 | 22 | SE | 61.4 | 8.6 | 0.0 | 21.4 | 3.6 | 5.0 |
| 2 | 47 | 72 | 30 | 24 | 21 | 38.8 | 6700 | 11 | E | 0.7 | 20.0 | 31.4 | 20.7 | 27.1 | 0.0 |
| 3 | 63 | 33 | 23 | 15 | 20 | 30.8 | 6500 | 12 | SE | 0.0 | 61.4 | 7.1 | 12.1 | 19.3 | 0.0 |
| 4 | 43 | 28 | 28 | 49 | 54 | 40.4 | 7500 | 22 | E | 67.1 | 6.4 | 3.6 | 7.1 | 3.6 | 12.1 |
| 5 | 100 | 72 | 49 | 23 | 56 | 60.0 | 6900 | 13 | SE | 20.0 | 22.1 | 6.4 | 20.7 | 29.3 | 1.4 |
| 6 | 64 | 55 | 49 | 37 | 31 | 47.2 | 6500 | 15 | SE | 1.4 | 8.6 | 17.9 | 45.0 | 25.7 | 1.4 |
| 7 | 39 | 24 | 11 | 21 | 22 | 23.4 | 7500 | 27 | S | 84.3 | 2.1 | 0.0 | 2.1 | 0.0 | 11.4 |
| 8 | 31 | 25 | 21 | 16 | 17 | 22.0 | 7000 | 17 | SE | 20.7 | 29.3 | 3.6 | 27.8 | 15.0 | 3.6 |
| 9 | 9 | 18 | 14 | 9 | 12 | 12.4 | 6700 | 17 | S | 3.6 | 22.9 | 8.5 | 43.6 | 21.4 | 0.0 |
| Avg. | 51.0 | 43.2 | 28.6 | 27.8 | 31.7 | 36.4 | 6950 | 17.3 | SE | 28.8 | 20.2 | 8.7 | 22.3 | 16.1 | 3.9 |
| DOW est. by Aerial Count[6/] | 52.4 | 43.6 | 23.2 | 27.9 | 31.6 | 35.7 | | | | | | | | | |

1/ Based on pellet group counts with a defecation rate of 13 pellet groups per deer per day.

2/ Based on an average of 165 days in the winter accumulation period.

3/ Number represents average difference from horizontal in degrees for 140 plots in each block and includes all horizontal plots.

4/ Compass directions south, southeast, and east are represented by the letters S, SE and E, respectively.

5/ Vegetation types are represented by: MB = Mixed Brush; SB = Sagebrush; PJ = Pinyon-Juniper; MP = Mixed Brush/Pinyon-Juniper; SP = Sagebrush/Pinyon-Juniper; OT = other vegetation type.

6/ DOW data for years 1977-1980 from Colorado Division of Wildlife Game Research Reports July 1978; July 1979 and July 1980. DOW data for years 1980-1982 from John Ellenberger CDOW big game biologist, personal communications.

than the 1979-80 and 1980-81 estimate of 28 deer/mi$^2$, it is considerably lower than the peak density of 51 deer/mi$^2$ found in 1977-78. For the five winters of study, the average density has been 36 deer/mi$^2$. See RBOSC MDP Monitoring Report Nine (RBOSC 1982a) for a discussion of the effects of the winter die back and possible recovery of the Piceance deer herd.

Pellet group plot descriptors averaged by block are also presented in Table 3-22 (see Appendix 3-2.1 for the descriptors for each plot). These descriptors give an indication of habitat quality available for deer. Table 3-22 shows that certain blocks in the RBOSC study area consistently have higher deer density estimates. Primary winter requisites for deer are nutrition, thermal protection and predator avoidance. How deer obtain these requisites is a matter of debate among wildlife biologists. It is probably safe to say that mule deer will roam over available habitat searching for these requisites. Deer movements may be governed by the amount of habitat available (that portion of the winter range suitable due to snow depth) and the amount of requisites available in that habitat. If an abundance of food, adequate thermal protection and limited predator pressure exist in close proximity, deer movements may be over a small area for a short period each day. However, as the availability of essential nutrition declines, deer must spend more time searching for food. This problem is compounded later in the winter when the size of the winter range is reduced by snow cover and the available food supplies dwindle.

Mule deer generally pass the winter in a body maintenance mode and seldom put on body weight (Short 1981). In fact, it is likely that deer metabolism is geared to losing weight during winter and is dependent upon fat and lean body reserves built up during the summer and fall. Habitats unavailable to deer in winter due to snow cover usually offer more available food because of the moisture provided by that snow cover. Therefore, as those habitats become available throughout the winter and in the spring as snow cover recedes, deer use of them greatly increases as the deer attempt to restore body nutrients lost over the winter. This increased deer use may be represented by high pellet group deposition over a short time. Because deer may concentrate in each successive habitat type

as it becomes available, pellet group densities in a particular habitat reflect only the importance of that habitat to deer survival, and do not reflect the length of time the habitat was used nor when it was used.

All of the pellet group plots in the RBOSC study area were segregated according to categories of elevation, slope, aspect and vegetation type. A Duncan's Multiple Range Test was performed on each category for each winter period of data accumulation. These tests are presented in Appendix 3-2.3. Very few significant differences appeared among the various plot elevations, slopes, aspects and vegetation types. This is probably an indication that deer use all available habitats during particular segments of the winter pellet group accumulation period, as explained above. This more or less uniform use of different habitats indicates the importance of habitat diversity, which enables deer to survive the winter.

## B. Mule Deer Road Kill Survey

### 1. Objectives

The objective of this program is to determine mule deer mortality due to collisions with vehicles along Rio Blanco County Road 24, from the Piceance Creek Road to Tract C-a.

### 2. Methods

The methods for collection of these data are described in RBOSC MDP Monitoring Report 5 (RBOSC 1980).

### 3. Results and Discussion

The only observed deer road kill along County Road 24 during 1982 occurred April 11 at milepost 11.6. The dead animal was an adult female. Reduced traffic along the road and limited snow depth, which allowed the deer to travel in areas away from the road, are probably the major factors contributing to this low number of kills.

C. Feral Horse Abundance

1. Objectives

Feral horses occur on and in the vicinity of Tract C-a. These horses are protected under federal law and are under the jurisdiction of the BLM. Feral horses compete with cattle and, to a lesser extent, with mule deer for available forage. The objective of feral horse monitoring studies is to provide qualitative information concerning the status of feral horses in the RBOSC study area (note: the feral horse study area is the same as that for the mule deer).

2. Methods

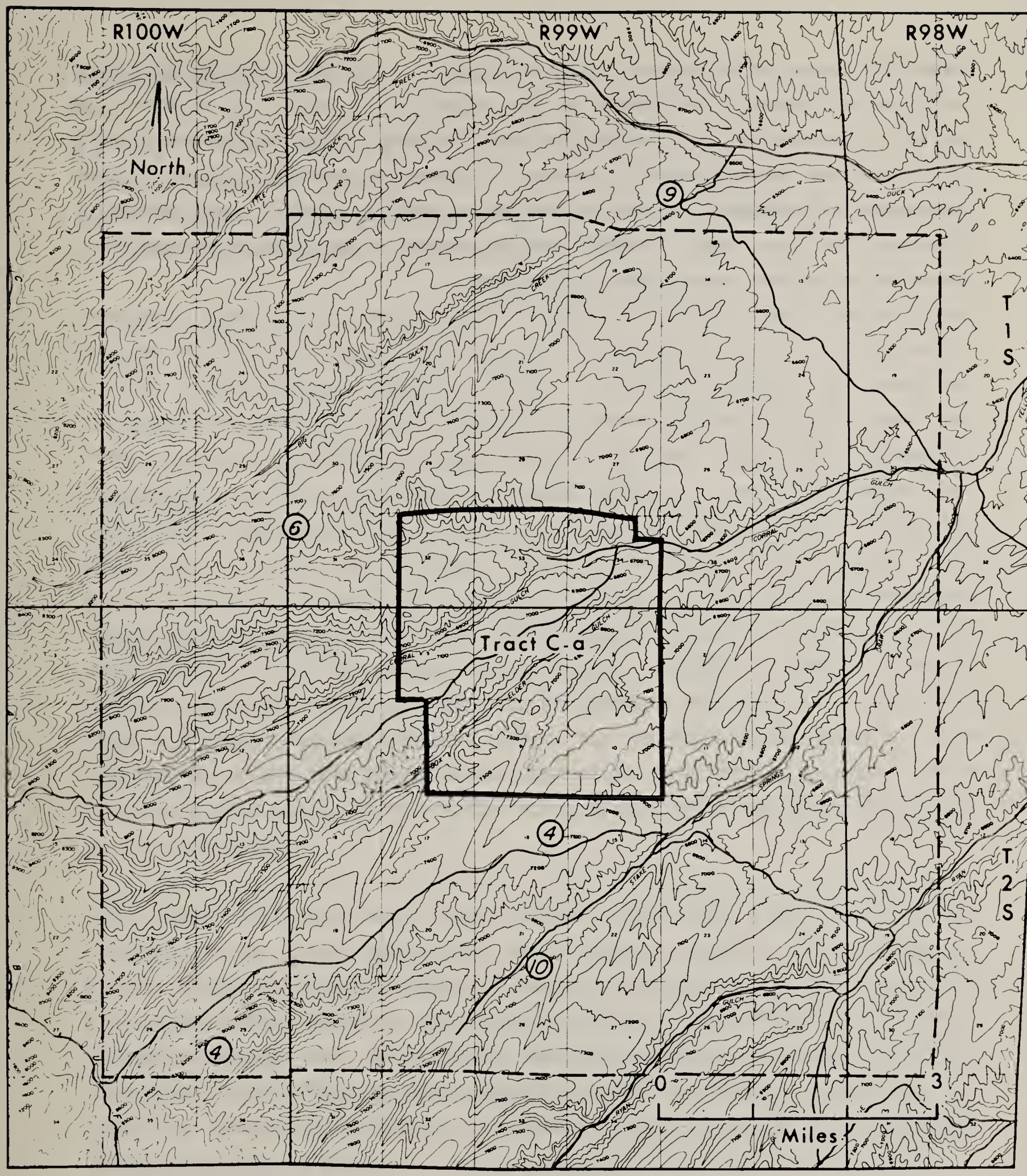
The methods followed for collection of data on feral horses are described in RBOSC MDP Monitoring Report 1 (RBOSC 1978a).

3. Results and Discussion

Feral horses were counted on the Tract C-a study area from a helicopter in January 1982. Data on this count are presented in Appendix 3-2.4. Four bands of horses totalling 24 individuals were observed (Figure 3-2). This is the fewest horses counted since the study began in 1978. A foal success survey, although conducted twice in 1982, failed to determine an age ratio in the feral horse population around C-a because no horses were seen. The low number of horses in the RBOSC study area can probably be attributed to the success of the BLM feral horse round-ups conducted in the Piceance Basin in 1980 and 1981. No BLM feral horse round-up was held in the Piceance Basin in 1982, and it is expected that the number of feral horses in the Tract C-a study area will increase.

D. Threatened, Endangered and Protected Species

Baseline, interim, and MDP environmental studies indicate that Tract C-a and the surrounding area does not provide critical habitat for any state or




④ Number of Horses in Band and Approx. Location of Band

— — — Feral Horse Study Area

Figure 3-2. Feral Horses Observed During January 19, 1982 Aerial Census

federally protected endangered wildlife species. The only species in these categories regularly observed in the vicinity of Tract C-a is the bald eagle. This species is occasionally seen foraging in the area and feeding on dead deer during winter months. Golden eagles and other raptors protected in Colorado were seen during the reporting period. Some of these species are year long residents and may nest in the area. No nests are known to occur near development activities.

## 3.3 SUMMARY

The components of the Terrestrial Monitoring Program examined during the 1982 reporting period include browse condition and utilization, phytosociology, range production and utilization, mule deer abundance, feral horse abundance and mule deer road kills.

Browse condition and utilization studies indicated that the weighted average utilization ranged from 6 percent in the Mixed Brush to 16 percent in the Pinyon-Juniper vegetation type. Utilization during 1982 remained the same for the Mixed Brush type but increased substantially in both the Pinyon-Juniper and Sagebrush types relative to 1981. Sagebrush (Artermisia tridentata) was the most heavily browsed species in the Mixed Brush and Sagebrush vegetation types, 11 and 12 percent respectively. Although utilization of sagebrush also was substantial in the Pinyon-Juniper type (19 percent), bitterbrush (Purshia tridentata) and mountain mahogany (Cercocarpus montanus) exhibited approximately twice the utilization of sagebrush, 47 and 38 percent respectively. Higher levels of browse utilization may indicate that the size of the mule deer herd is increasing from the lower numbers present after the harsh 1978-79 winter. Low utilization within the Mixed Brush vegetation type probably results from limited winter access to the north-facing slopes where the Mixed Brush type is typically found.

Only minor variations were noted between 1982 and 1981 data for the distribution of shrub species by form, age and hedging classification. Range condition ratings based on hedging classification were generally better than those based on age classification. Aside from bitterbrush, mountain mahogany and serviceberry which were rated as being in "poor" condition in the Pinyon-Juniper vegetation type, all species were either in "good" or "excellent" condition, as based on the percentage of individuals which were severely hedged.

Seven years of data concerning browse condition and utilization of seven shrub and/or tree species within three vegetation types have documented the

relative abundance of the species, variations in use of different species, variations in use patterns, the distribution of the species among age classifications, and the varying degrees of hedging which the species display in the Tract C-a vicinity. These data will be of use as a baseline for comparison of browse condition and utilization during future activities in the vicinity of Tract C-a and serve to indicate which browse species might be most beneficial for use in revegetation efforts.

In general, results indicate that the Pinyon-Juniper type was used more heavily than either the Mixed Brush or Sagebrush types. Heavier use of the Pinyon-Juniper type was expected because this habitat type is typically found on southerly exposures, or on ridgetops adjacent to southerly exposures, where winter snow depths allow for movement of the deer and access to low lying shrub species. Because of the heavier use of Pinyon-Juniper relative to the other two vegetation types sampled, average utilization of most species within that type tends to be heavier than for the corresponding species in other vegetation types. Concomitant with heavier leader utilization, a greater percentage of species in the Pinyon-Juniper type exhibited severe hedging. This is particularly the case for bitterbrush, mountain mahogany, and sagebrush, the three species which received the heaviest leader use in the Pinyon-Juniper as well as in the other vegetation types.

Variations in mule deer use patterns based on the browse utilization data are difficult to ascertain. However, data seem to indicate that, providing all other factors are equal, deer are not inhibited from using sites adjacent to MDP activities on Tract C-a. Because the deer seem to require some sort of protective cover relatively close to browsing sites, some of the variability in use patterns evidenced by these utilization data may be related to positioning of individual transects within a given vegetation type. For example, a transect within the Sagebrush type which happens to be adjacent to a Pinyon-Juniper stand, which provides readily accessible cover, may receive more use than another sagebrush transect in the middle of a large opening. Considerations of this sort should be taken into account in designing future monitoring programs.

These browse data offer a unique opportunity to study intraspecific variations in sagebrush as they relate to mule deer preference. Because the same individuals were, for the most part, sampled every year, these data can be used to identify those individuals which are consistently heavily browsed. By testing these individuals relative to other less heavily browsed sagebrush individuals along the same transects, intraspecific differences could be documented. Results of these studies would be beneficial to reclamation as well as mitigatory planning for future Tract C-a operations.

Baseline phytosociological data were collected from Area 6 (control) and from Areas 5 and 7 (treatments) during 1982. Percent cover of herbaceous species in the Pinyon-Juniper vegetation type ranged from 11.3 in Area 6 to 15.2 in Area 7. Although fewer species of grasses than forbs were encountered, the grasses accounted for the largest proportion of the total cover. No significant differences in cover of grasses or forbs were noted between sample periods, among transects within an area, or among areas for the Pinyon-Juniper vegetation type.

Cover of herbaceous species in the Sagebrush vegetation type exceeded that encountered in the Pinyon-Juniper type, with a range of from 30.8 in Area 7 to 41.0 percent in Area 6. As with the Pinyon-Juniper type, cover of grasses generally exceeded that of forbs; however, the disparity between growth forms was not as pronounced. The cover of forbs differed significantly among areas, but cover of forbs within a given area or between sample years did not vary significantly. Such differences, which result from natural variations, must be taken into account when these data are used to assess potential impacts of Tract C-a operations.

The phytosociological studies which began in 1979 have served to document plant community composition and structure within Sagebrush and Pinyon-Juniper vegetation types. Phytosociological data will be useful for comparison against which potential impacts can be assessed. Thus far, data from the "control" and "treatment" areas show few significant differences between areas, among transects within a given area, or between sample

periods for a given vegetation type. Consequently, the data base should be useful as a baseline for indirect comparisons provided that future potential impacts are in the general vicinity of Tract C-a. Phytosociological data are also useful as references of species composition and/or diversity against which reclamation success can be assessed.

Range productivity and utilization studies indicated that production ranged from 118.8 kg/ha in the Pinyon-Juniper type to 415.6 kg/ha in the Mixed Brush vegetation type. Production within caged (protected) sample locations increased during 1982 relative to 1981 within the Pinyon-Juniper type, but decreased for both Mixed Brush and Sagebrush types. Utilization of herbaceous vegetation, as based on a comparison of standing crop within caged and uncaged plots, appeared to have increased somewhat within the Pinyon-Juniper type and decreased within both the Mixed Brush and Sagebrush types relative to 1981 data.

Statistical comparisons of range production among transects sampled in 1982 within three vegetation types indicated significant differences for grass production within both caged and uncaged plots in the Sagebrush type, and for forbs encountered in uncaged plots of the Pinyon-Juniper type. Variations among years (1978 through 1982) were also evident. Significant differences in grass production were noted within uncaged plots for all three vegetation types. Variations in forb production in uncaged plots were significant for the Sagebrush type. Production in caged plots, which were not available to grazing, also varied significantly for grasses in the Pinyon-Juniper type, and for both grasses and forbs in the Sagebrush type. Differences in production within uncaged plots may be related to variations in grazing pressure while those evidenced for caged plots may represent natural variations related to site conditions.

Range production and utilization data collected within three vegetation types over a five year period serve to document the production (standing crop) and utilization (comparison of standing crop within protected vs unprotected sample locations). Production within protected plots serves to identify natural variations in growth that result from climatic differences

over years. These data largely reflect differences which are not related to development of Tract C-a (eg. climatic variability and variable use of BLM-regulated livestock grazing allotments). However, some tract-related activities may actually have promoted livestock and wildlife use of the area. Discharge of water into areas otherwise occupied by ephemeral streams and revegetating disturbed areas have been observed to attract both livestock and wildlife. Range production data will serve as criteria against which revegetation success can be judged during future reclamation activities.

Production of grasses and forbs within the Mixed Brush type averaged 320 kg/ha over five years of study, as compared to 255 kg/ha in the Sagebrush and 79 kg/ha in the Pinyon-Juniper types. Utilization between years within a given vegetation was variable, but the Sagebrush and Mixed Brush types generally were used more heavily than the Pinyon-Juniper type. Data have provided some indication of use patterns (primarily those of livestock) in the vicinity of Tract C-a. There have appeared to be no adverse effects relative to tract development. The variations in production among years are thought to be related primarily to climatic conditions, whereas differences in utilization over time probably reflect variability in the use of BLM grazing allotments in the vicinity of Tract C-a.

Winter density of mule deer estimated from pellet group counts around Tract C-a, has apparently increased since the 1978-79 winter die off. The winter density of deer per square mile in the RBOSC study area has ranged from a high of 51 in 1977-78 through a low of 28 in 1979-80 and 80-81 back up to 32 in 1981-82. The average number of deer per square mile for the five winters of study is 36. Distribution of pellet groups across habitat types, slopes, aspects and elevation ranges indicate that deer may be found in almost all ecotypes in the RBOSC study area at various times throughout the winter, depending upon the severity of the winter.

Only one deer road kill was observed along Rio Blanco County Road 24 during the reporting period. This reduction in road kills from previous years is probably a function of reduced traffic and limited snow depth which allowed the deer to roam in areas away from the road.

Four bands of horses totalling 24 individuals were observed in the January 1982 feral horse count on the Tract C-a study area. This is the fewest horses counted since the study began in 1978; probably a result of the success of the BLM feral horse round-ups conducted in the Piceance Basin in 1980 and 1981.

The Tract C-a and surrounding area do not provide critical habitat for any state or federally designated threatened or endangered species. The Bald Eagle is occasionally seen in the winter months foraging in the area. Golden Eagles and other raptors protected in Colorado are year long residents and may nest in the area.

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# SECTION 4
# AQUATIC STUDIES

## 4.0 INTRODUCTION

The MDP Aquatic Monitoring Program is designed to provide information on the aquatic ecosystems in the vicinity of Tract C-a, and to identify and measure the potential effects of oil shale development on local aquatic biota. Table 4-1 lists the frequency of parameters measured at the four locations sampled.

The four sampling stations used for the 1982 MDP monitoring program are as follows (Figure 4-1):

- Station CG-1 at the USGS gaging station in Corral Gulch (east)
- Station YC-1 on Yellow Creek approximately 100 meters below the confluence of Stake Springs Draw and Corral Gulch
- Station YC-2 on Yellow Creek at the road crossing approximately 10 km upstream from the confluence of the White River and Yellow Creek
- Station YC-3 at the USGS gaging station in Yellow Creek, approximately 400 meters upstream from the confluence of Yellow Creek and White River

Sampling for the MDP Aquatic Monitoring Program was initiated in October 1977 at Stations CG-1 and YC-3. Stations YC-1 and YC-2 were added to the sampling program in 1981 because of their intermediate downstream locations relative to the aforementioned sites. Station YC-1 was dry during the July 1982 sampling period. This report provides the results of the 1982 MDP aquatic studies and comparisons of these results to those data collected during previous years.

Table 4-1. Aquatic Studies Monitoring Schedule

| Parameter | Location | Frequency |
|---|---|---|
| ABIOTIC COMPONENTS: | | |
| Physical Measurements | All Stations (see Figure 4.1) | 3 Times/yr (April, July, October) |
| Total Dissolved Solids | | |
| Stream Velocity and Flow | | |
| Turbidity | | |
| Dissolved Oxygen | | |
| pH | | |
| Specific Conductance | | |
| Depth | | |
| Width | | |
| Stream Substrate | | |
| Suspended Solids | | |
| Temperature | | |
| Alkalinity | | |
| Basic Water Quality Measurements | All Stations | 3 Times/yr (April, July, October) |
| Calcium | | |
| Magnesium | | |
| Potassium | | |
| Sodium | | |
| Bicarbonate | | |
| Carbonate | | |
| Chloride | | |
| Nitrate | | |
| Sulfate | | |
| Fluoride | | |
| Ammonia | | |
| Total Phosphate | | |
| Boron | | |
| Silica ($SiO_2$) | | |
| Iron | | |
| Dissolved Organic Carbon | | |
| Arsenic | | |
| Selenium | | |
| Vanadium | | |
| Molybdenum | | |
| Mercury | | |
| Trace Water Quality | All Stations | 1 Time/yr (October) |
| Aluminum | | |
| Barium | | |
| Beryllium | | |
| Bismuth | | |
| Bromide | | |
| Cadmium | | |
| Chromium | | |
| Copper | | |
| Gallium | | |
| Germanium | | |
| Lead | | |
| Lithium | | |
| Manganese | | |
| Nickel | | |
| Strontium | | |
| Titanium | | |
| Zinc | | |
| Zirconium | | |
| BIOTIC COMPONENTS: | | |
| Periphyton | All Stations | 3 Times/yr (April, July, October) |
| Taxonomic Composition | | |
| Density | | |
| Diversity | | |
| Benthos | All Stations | 3 Times/yr (April, July, October) |
| Taxonomic Composition | | |
| Density | | |
| Diversity | | |

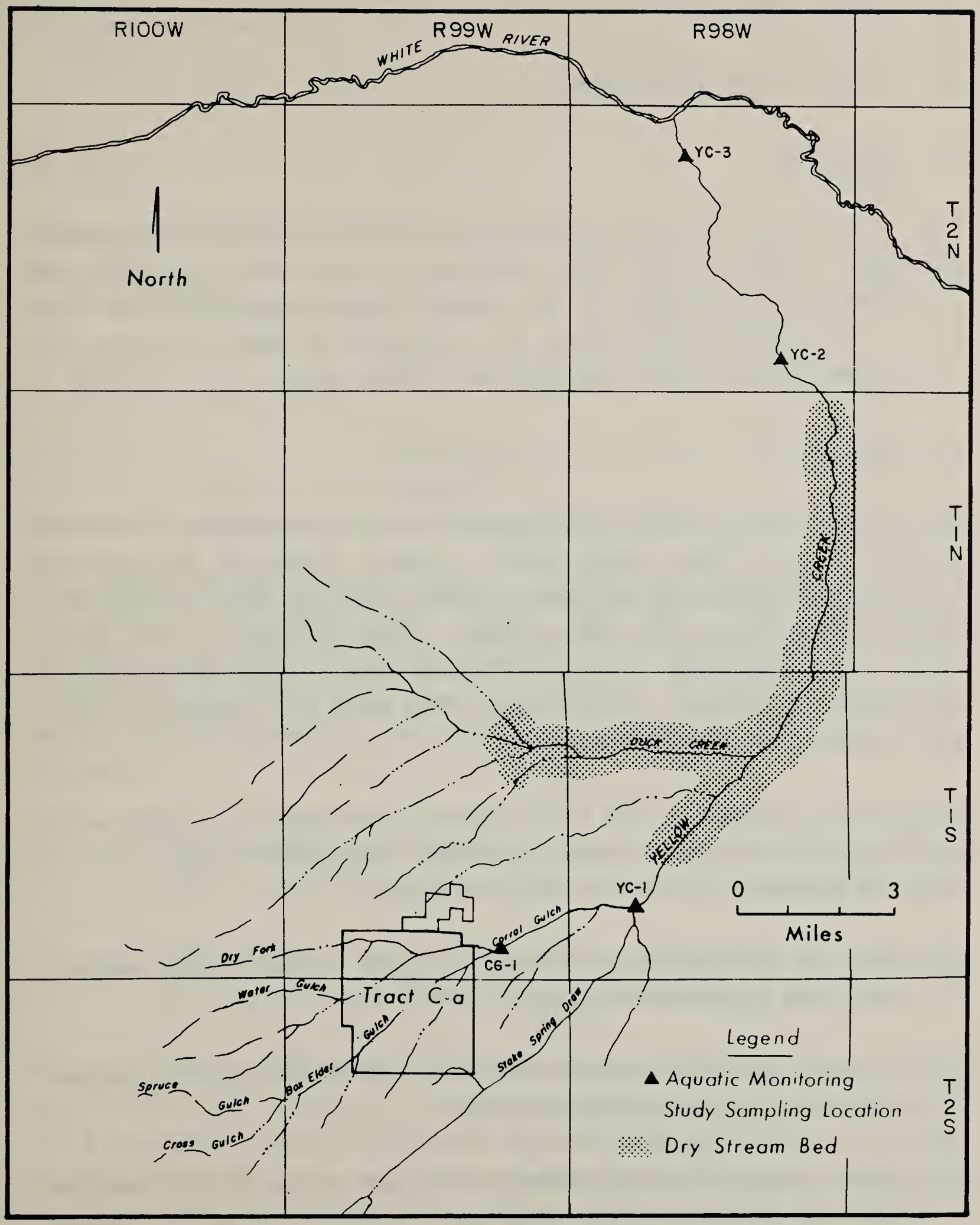


**Figure 4-1. MDP Aquatic Monitoring Station Locations**

## 4.1 ABIOTIC COMPONENTS

### A. Stream Physical Measurements

#### 1. Objectives

Field water quality (FWQ) and aquatic habitat characterization measurements are made at each of the four stations to evaluate natural and development-related changes in the aquatic habitat downstream from Tract C-a. Field water quality data are collected at these locations in conjunction with biological data observed at each site.

#### 2. Methods

The methods used to collect stream physical data are described in the RBOSC approved Scope of Work (RBOSC 1981). Several changes in the sampling locations and methodology were made and approved by the OSO. Stations WR-1 and WR-2 were dropped from the program. These stations, on the White River, were determined to be of limited use for the monitoring and evaluation of development related impacts from Tract C-a. Figure 4-1 shows the stations presently being monitored.

Comparisons of changes in the stream physical measurements are made using the Analysis of Variance (ANOVA) techniques described in Table 4-2. The following hypotheses are tested using this ANOVA:

$H_o$: There are no significant differences in each of the physical measurements made between years sampled.

$H_o$: There are no significant differences in each of the physical measurements made between sampling locations.

$H_o$: There are no significant differences in each of the physical measurements made between sampling seasons.

Table 4-2. Three-way Model I Analysis of Variance, Without Interaction, Design for the evaluation of Stream Physical Parameters

| Source | df | F-Test | Expected MS. (Model 1) |
|---|---|---|---|
| A. Years | a-1 | A/D | $\sigma^2 + \frac{bc}{a-1}\sum_{a}\alpha^2$ |
| B. Stations (4 stations) | b-1 | B/D | $\sigma^2 + \frac{ac}{b-1}\sum_{b}\beta^2$ |
| C. Seasons (Spring, Summer, Fall) | c-1 | C/D | $\sigma^2 + \frac{ab}{c-1}\sum_{c}\gamma^2$ |
| D. Error | abc(n-1) | | $\sigma^2$ |
| Total | (nabc)-1 | | |

As a special analysis for this report, a stepwise discriminant analysis was performed on the field water quality (FWQ) data. This procedure was completed to evaluate those FWQ parameters which are the most significant contributors to change among sampling locations. Parameters are chosen to enter or be eliminated from the discriminant model according to one of two criteria:

1. The parameter being considered for inclusion to the discriminant model is significant at $P > 0.10$ in an analysis of covariance.

2. The squared partial correlation coefficient is significant ($P > 0.05$) for the parameter being considered.

Stepwise selection begins with no parameters in the model and the significance level set at $P > 0.10$ for entry into the model. At each step, if a parameter already in the model does not meet the criterion to remain in the model, the worst, or least significant, contributing parameter is removed. Otherwise, the physical parameter that contributes most to the

discriminatory power of the model, as measured by Wilks' Lambda Statistic, is entered and tested in the model. The following hypotheses are tested using the stepwise discriminant analysis.

$H_o$: The parameter being considered for inclusion in the discriminant function is not a significant contributor to station independence (determined by analysis o covariance).

$H_o$: The parameter being tested in the discriminant model is not a significant discriminator of stations sampled (determined by stepwise selection in a discriminant function).

## 3. Results and Discussion

A comparison of the physical measurement means for each station during the MDP monitoring program are presented in Table 4-3. These data indicate that a high degree of variability exists among the stations sampled, and that a progressive increase in conductivity occurs as one proceeds downstream from Tract C-a. Field water quality data collected during the 1982 season are listed in Appendix 4-1.1.

Table 4-3. Stream Field Water Quality Means for each station sampled in the MDP Monitoring Program (1978-1982).

| | Station Mean | | | |
|---|---|---|---|---|
| Parameter | CG-1 | YC-1 | YC-2 | YC-3 |
| Temperature | 13.4 | 12.8 | 16.5 | 14.8 |
| Conductivity | 1380.7 | 1840.0 | 2317.5 | 3654.5 |
| Dissolved Oxygen | 7.3 | 9.5 | 10.3 | 8.9 |
| pH | 7.8 | 8.2 | 8.4 | 8.6 |

Figures 4-2 to 4-5 display the FWQ station and seasonal distribution for physical data collected in 1982. Figure 4-2 shows that a very high degree of seasonal and station variability exists for water temperature. This observation is expected for water temperature. Results from the ANOVA and

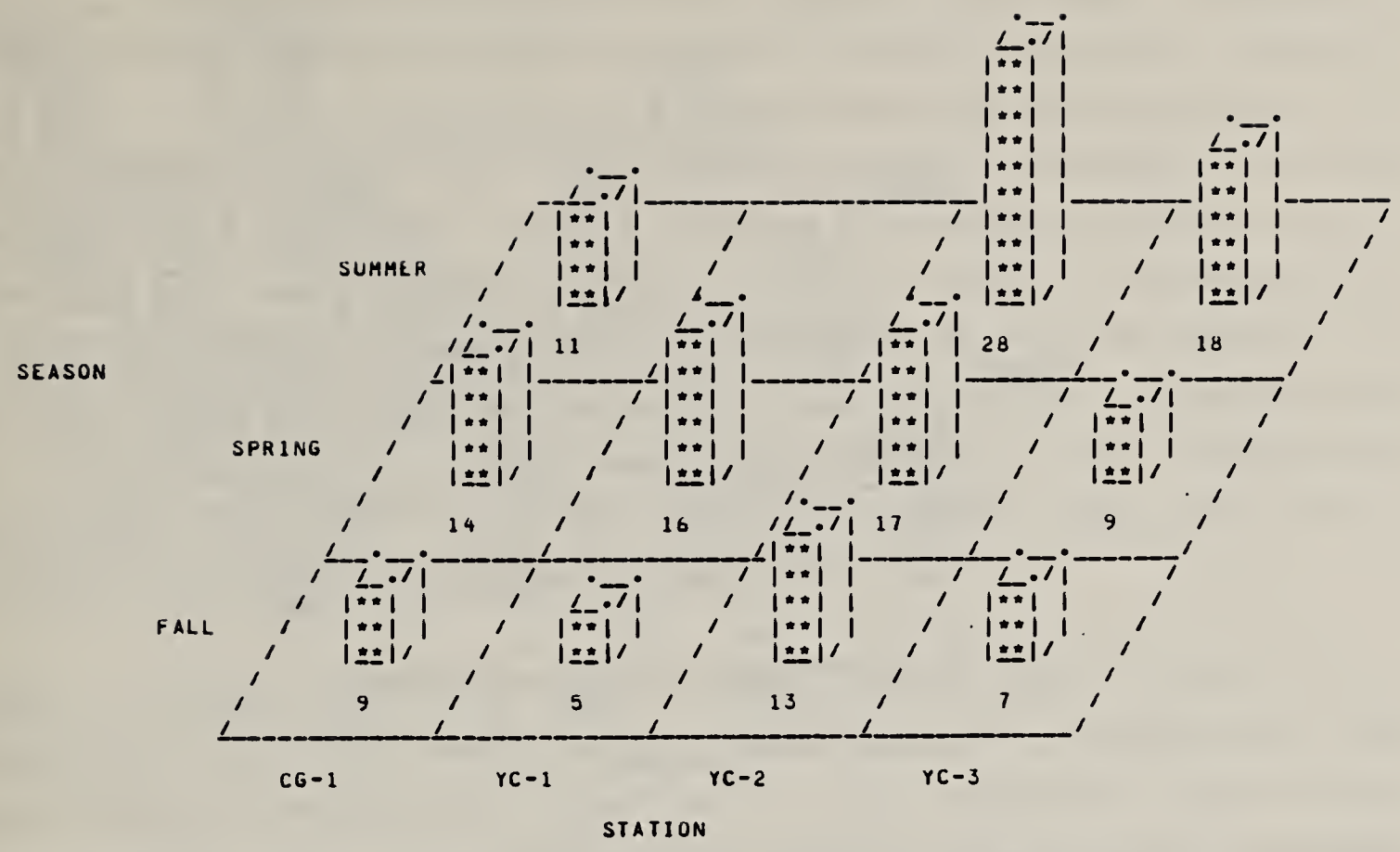


Figure 4-2. Mean Temperature (°C) Distribution over Seasons and Stations During the 1982 Sampling Season.

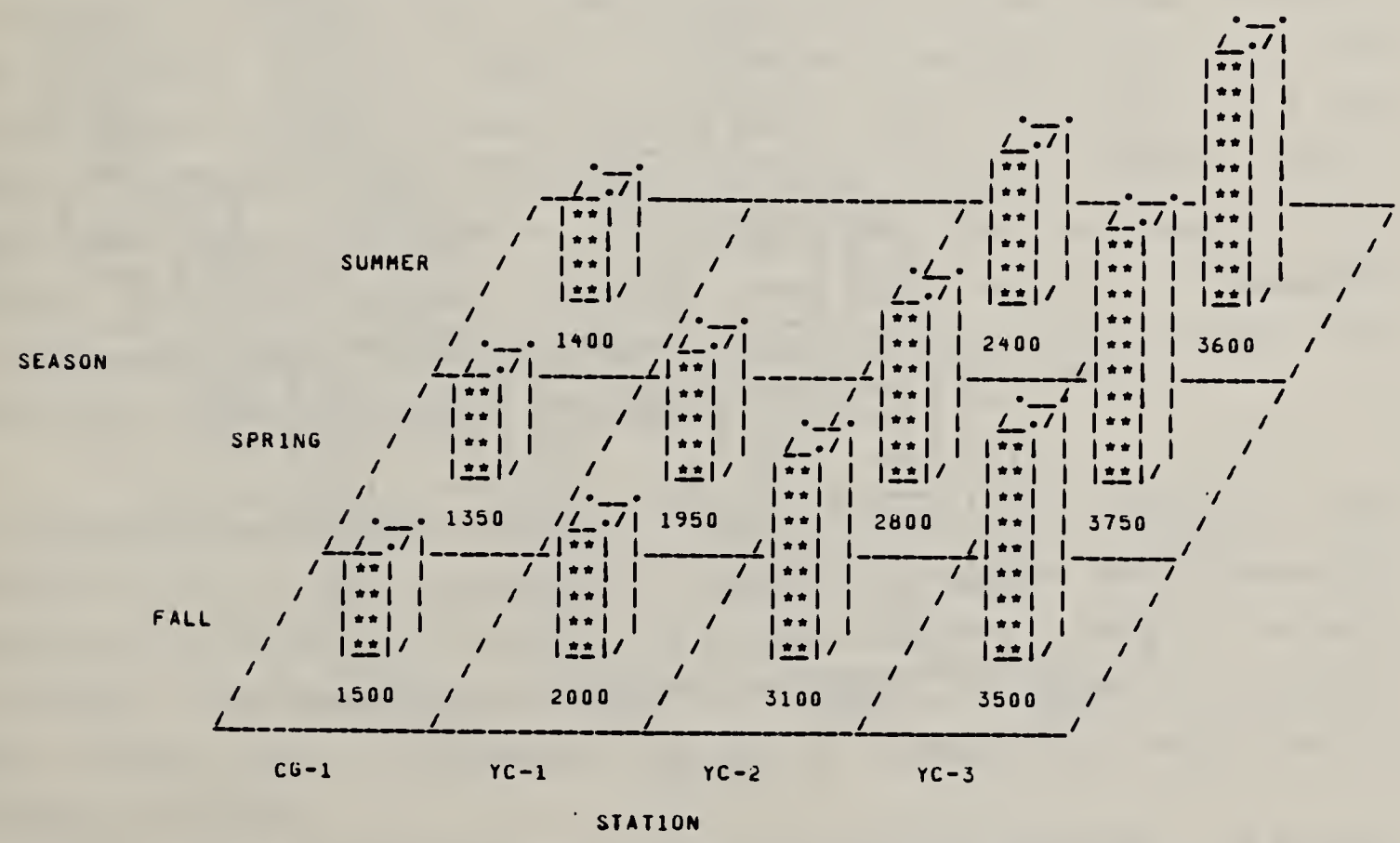


Figure 4-3. Mean Conductivity (micromhos/cm) Distribution over Seasons and Stations During the 1982 Sampling Season.

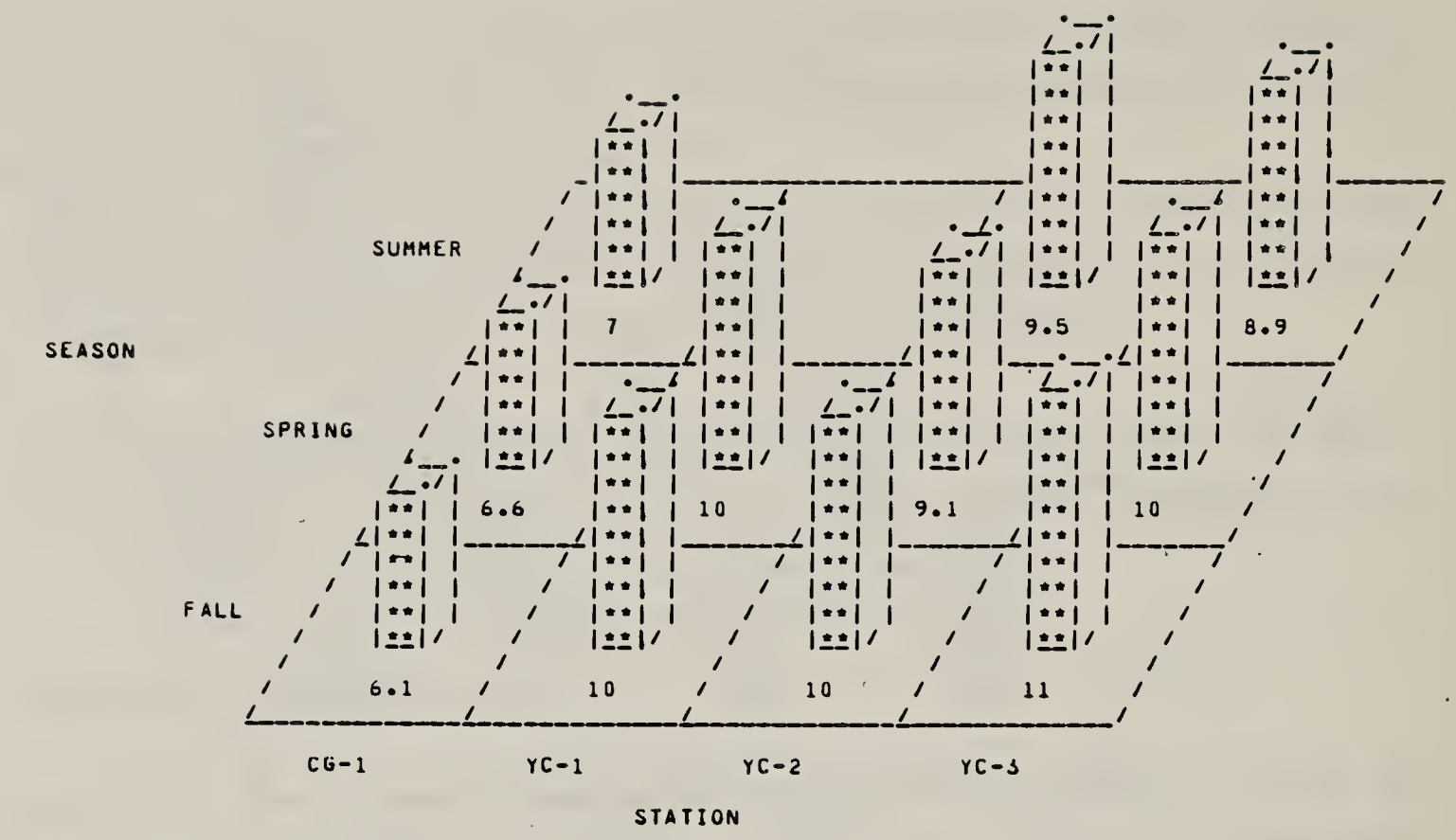


Figure 4-4. Mean Dissolved Oxygen (mg/l) Distribution over Seasons and Stations During the 1982 Sampling Season.

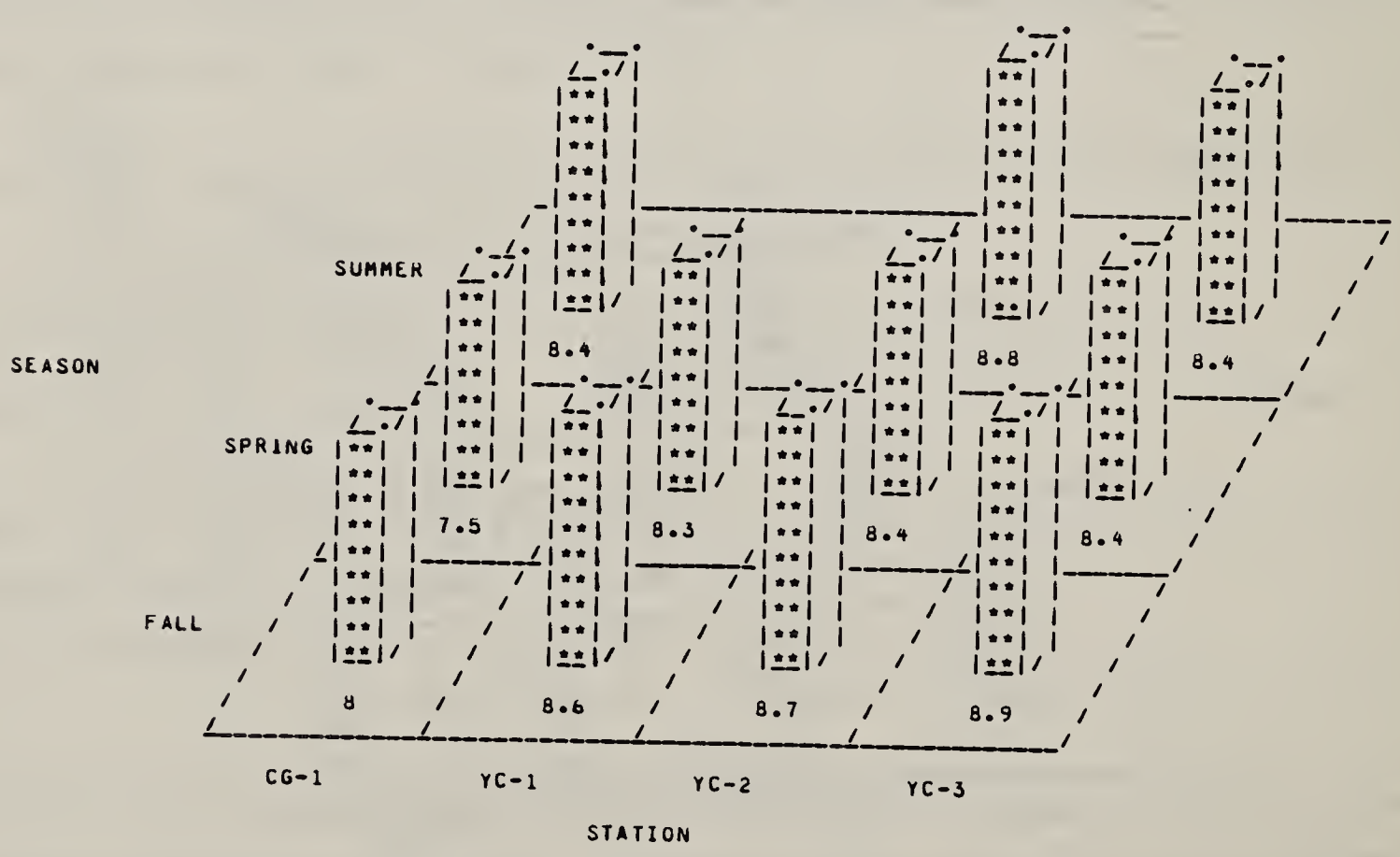


Figure 4-5. Mean pH (S.U.) Distribution over Seasons and Stations During the 1982 Sampling Season.

stepwise discriminant analysis both indicate that water temperature exhibits a high degree of variability and is a poor discriminant between stations. Table 4-4 summarizes the results from the ANOVA analysis; the Duncan's Multiple Range Test results for the parameter temperature are in Appendix 4-1.3. Results from the stepwise discriminant analysis are in Appendix 4-1.2, and are summarized in Table 4-5. Note in Table 4-5, part A, that the parameter temperature was nonsignificant for the Analysis of Covariance selection technique and was not considered for inclusion into the discriminant model. Results presented herein for water temperature measurements show that it is an unreliable parameter for the overall evaluation of physical differences at each station.

Figure 4-3 shows conductivity data the 1982 sampling year. Station CG-1, located near Tract C-a, exhibited the lowest seasonal conductivities, with values becoming progressively higher as one moves downstream from Station CG-1. Overall, the conductivities have averaged between 1380.7 micromhos per cm at CG-1 to 3654.5 micromhos per cm at Station YC-3 (Table 4-3). This progressive increase in downstream conductivity indicates an increase in the amount of salt being introduced into the stream system. Results from the ANOVA and the stepwise discriminant analyses show that this spatial change in conductivity is statistically significant (Tables 4-4 and 4-5). The ANOVA results presented in Table 4-4 also indicate that a significant change in conductivity has occurred over the years sampled (see Appendix 4-1.3 for Duncan's Multiple Range Test results). Table 4-4 indicates that the treatment effect season is not significant for conductivity measurements made in this program.

The stepwise discriminant analysis results (Table 4-5) indicate that conductivity is the single most important parameter being measured, accounting for 83.3% of the variability between stations. When the second parameter, dissolved oxygen, is added to the model, the amount of variation among stations that is accounted for by the conductivity measurements increases to 83.6%.

Table 4-4. Summary results for the Analysis of Variance (ANOVA) performed on the Field Water Quality (FWQ) measurements collected in the Aquatic Monitoring Program.

| Parameter Measured | Model[1/] $r^2$ | Source of Variation: Station D.F. | Station F Value | Station PR>F | Report Year D.F. | Report Year F Value | Report Year PR>F | Season D.F. | Season F Value | Season PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| Water Temperature | 0.56 | 3 | 1.20 | 0.3217 | 8 | 1.93 | 0.0819 | 2 | 15.97** | 0.0001 |
| Conductivity | 0.91 | 3 | 125.30** | 0.0001 | 8 | 4.35** | 0.0008 | 2 | 0.08 | 0.9211 |
| Dissolved Oxygen | 0.51 | 3 | 9.73** | 0.0001 | 8 | 1.38 | 0.2331 | 2 | 0.91 | 0.4119 |
| pH | 0.63 | 3 | 17.26** | 0.0001 | 8 | 1.79 | 0.1072 | 2 | 1.12 | 0.3347 |

1/ Model $R^2$ = The coefficient of determination value of how much variablity the use of this model will account for in the Source of Variation.

* Significant at P>0.05
** Significant at P>0.025

Table 4-5. Summary results for the Stepwise Discriminant Analysis performed to evaluate the FWQ variables contributing to change among stations[1/]

A. Analysis of Covariance entry statistics to the model[2/]

| Parameters | $r^2$ | F Value | Prob>F |
|---|---|---|---|
| Water Temperature | 0.0396 | 0.687 | 0.5640 |
| Conductivity | 0.8337 | 83.553 | 0.0001 |
| Dissolved Oxygen | 0.3556 | 9.196 | 0.0001 |
| pH | 0.4778 | 15.248 | 0.0001 |

B. Discriminant Stepwise selection of Physical Parameters

| Step Number | Parameter Entry | Partial[3/] $r^2$ | F Value | Prob>F | Wilk's Lambda (F Value) | Pillais' Trace (F Value) |
|---|---|---|---|---|---|---|
| Step 1 | Conductivity | 0.8337 | 83.55 | 0.0001 | 83.55 | 83.55 |
| Step 2 | Conductivity | 0.8363 | 83.47 | 0.0001 | | |
| | Dissolved Oxygen | 0.3658 | 9.42 | 0.0001 | 33.96 | 20.19 |
| Step 3 | No other parameters entered. No other signficant contributors | | | | | |

1/ Complete analysis results in Appendix 4-1.2

2/ Selection criteria for entry into discriminant analysis. Temperature will not be considered for selection.

3/ Partial $R^2$ value used to test for removal from the next step.

Results presented herein for the discriminant and ANOVA analyses indicate that the detection of either natural or development related changes in the stream physical conditions may first appear in conductivity data, because the stepwise discriminant analysis (Table 4-5) indicates that the majority of variability between stations sampled can be accounted for by measuring conductivity. ANOVA results (Table 4-4) also indicate conductivity is not significantly influenced by seasonal conditions.

The mean pH measurements varied slightly at each location sampled during 1982 (Figure 4-5). The ANOVA performed on the pH data indicated that a significant station effect was present while no significant sampling year or seasonal effects were evident (Table 4-4). Table 4-5, part A, indicates that pH was a significant covariate and was tested in the stepwise discriminant analysis. However, pH was not included as a significant contributor to the discriminant function, probably due to the small within class variance and sample standard deviation (Appendix 4-1.2). Overall, pH measurements indicate the same distributional pattern as conductivity (i.e. increasing pH with downstream location from Tract C-a).

Dissolved oxygen readings made at Station CG-1 in 1982 are somewhat lower than at Stations YC-1, YC-2 and YC-3 (Figure 4-4). The ANOVA results presented in Table 4-4 indicate that a significant station effect exists and that the time effects of year and season are nonsignificant independent variables. Results from the stepwise discriminant analysis (Table 4-5) indicate that dissolved oxygen and conductivity were the only FWQ parameters selected for inclusion into the stepwise discriminant analysis. These results indicate that dissolved oxygen measurements, like conductivity measurements, can be reliably used to evaluate and monitor changes between aquatic sampling stations.

B. Stream Water Chemistry Measurements

1. Objectives

The objective of the water chemistry data (BWQ and TWQ: Table 4-1) collection is to evaluate changes in water chemistry downstream from Tract C-a. Major changes in the water chemistry values could affect the benthic macroinvertebrate population. Therefore, water chemistry data are used to compare and evaluate changes in the biological conditions observed at each sampling site.

2. Methods

The methods used to collect the stream water chemistry samples are described in the RBOSC approved Scope of Work (RBOSC 1981). Water chemistry data are collected at the four monitoring stations shown in Figure 4-1.

As a special analysis for this report, comparisons of changes in the water chemistry are based on two separate analyses. A stepwise discriminant analysis was used to determine those major cations, anions, and general monitoring parameters that may be significant indicators of change among sampling locations. Table 4-1 shows the parameters and their sampling frequency. Three groupings were tested independently using this discriminant analysis: the major cations (Ca, Mg, Na, K, Fe), the major anions ($HCO_3$, $CO_3$, $SO_4$, Cl), and a general parameter list (TDS, TSS, ALK, $PO_4$, $NH_3$, $NO_3$, F, DOC). Trace water quality parameters (TWQ) were not tested. Inspection of the TWQ data for 1981 (RBOSC 1982a) and 1982 (Appendix 4-1.4) indicated that most of the TWQ parameters listed in Table 4-1 are less than the detection limits of the instruments used to analyze them. The following hypotheses were tested in the discriminant analysis:

$H_0$: The water chemistry parameter being evaluated is not significant enough for entry into the model (the same hypothesis and logic that was used for the physical data).

$H_o$: The water chemistry parameter being tested in the model is not a signifcant discriminator among stations (the same technique as described for the physical data).

The second technique used to evaluate the water chemistry data was a three-way Analysis of Variance, without interaction. This model was run without interaction because the results of this test are being evaluated such that each of the independent variables in the model is independent of the other. Table 4-6 shows the three-way ANOVA model being used. Dependent variables being considered for inclusion to the ANOVA are based on selection from the discriminant analysis. Water chemistry parameters selected as significant discriminators of sampling location are run in the ANOVA. The following hypotheses are being tested via the three-way ANOVA:

$H_o$: There is no significant difference in the water chemistry parameter measured between sampling years.

$H_o$: There is no significant difference in the water chemistry parameter measured between sampling locations.

$H_o$: There is no significant difference in the water chemistry parameter measured between sampling seasons.

Table 4-6. Three-way Model I Analysis of Variance, Without Interaction, Design for the evaluation of selected BWQ parameters

| Source | df | F-Test | Expected MS. (Model 1) |
|---|---|---|---|
| A. Years | a-1 | A/D | $\sigma^2 + \frac{bc}{a-1}\sum_{a}\alpha^2$ |
| B. Stations (4 stations) | b-1 | B/D | $\sigma^2 + \frac{ac}{b-1}\sum_{b}\beta^2$ |
| C. Seasons (Spring, Summer, Fall) | c-1 | C/D | $\sigma^2 + \frac{ab}{c-1}\sum_{c}\gamma^2$ |
| D. Error | abc(n-1) | | $\sigma^2$ |
| Total | (nabc)-1 | | |

## 3. Results and Discussion

Table 4-7 presents means for the major cations, anions, and general water quality parameters in the basic water quality analysis. Inspection of this table indicates that sodium, bicarbonate, total dissolved solids, alkalinity, and nitrates all show an increase in concentration with distance downstream from Tract C-a. Water chemistry data collected during the 1982 sampling season are presented in Appendix 4-1.4. Note that Station YC-1 was dry during the July sampling period, therefore no data exists.

Stations CG-1 and YC-1, near Tract C-a, exhibit higher calcium concentrations than the two downstream Stations YC-2 and YC-3 (Table 4-7). Table 4-8 summarizes the results from the major cation stepwise discriminant analysis. The complete results are presented in Appendix 4-1.5. Calcium was found to be a significant contributor to the discriminant function in the third step (Table 4-8, part B). Results from the ANOVA, presented in Table 4-9, indicate that no seasonal or yearly changes were significant

Table 4-7. Stream water chemistry means ($\bar{x}$) for the Basic Water Quality (BWQ)parameters (mg/l) measured in 1981 and 1982, at four stations.[1/]

| Parameter | Station Means | | | |
|---|---|---|---|---|
| | CG-1 | YC-1 | YC-2 | YC-3 |
| **Major Cations** | | | | |
| Calcium | 79.3 | 101.2 | 51.6 | 30.5 |
| Magnesium | 69.6 | 111.6 | 195.3 | 109.3 |
| Sodium | 166.6 | 224.0 | 420.5 | 761.0 |
| Potassium | 1.3 | 2.3 | 3.6 | 3.4 |
| Iron | 0.05 | 0.17 | 0.05 | 0.05 |
| **Major Anions** | | | | |
| Bicarbonate | 552.5 | 620.2 | 910.8 | 1539.8 |
| Carbonate | 1.0 | 1.0 | 5.8 | 21.6 |
| Sulfate | 366.5 | 600.7 | 991.2 | 665.2 |
| Chloride | 10.9 | 40.8 | 32.7 | 109.8 |
| **General Parameters** | | | | |
| Total Dissolved Solids | 993.3 | 1509.3 | 2280.7 | 2582.0 |
| Total Suspended Solids | 22.6 | 34.6 | 17.25 | 105.7 |
| Alkalinity | 459.3 | 560.6 | 877.0 | 1482.7 |
| Total Phosphate | 0.03 | 0.02 | 0.05 | 0.01 |
| Ammonia | 0.05 | 0.05 | 0.11 | 0.20 |
| Nitrate | 0.1 | 0.07 | 0.10 | 0.24 |
| Fluoride | 0.45 | 0.21 | 0.49 | 1.79 |
| Dissolved Organic Carbon | 3.3 | 11.0 | 9.0 | 8.75 |

1/ Mean values are based on three sampling periods in 1981 and three periods in 1982 (6 total samples). 1982 data are listed in Appendix 4-1.4.

Table 4-8. Summary results of the Stepwise Discriminant Analysis performed to evaluate the major cation variables contributing to change among stations.[1/]

A. Analysis of Covariance entry statistics to the model[2/]

| Parameters | $r^2$ | F Value | Prob>F |
|---|---|---|---|
| Calcium | 0.8539 | 37.022 | 0.0001 |
| Magnesium | 0.7560 | 19.628 | 0.0001 |
| Sodium | 0.9762 | 260.231 | 0.0001 |
| Potassium | 0.5763 | 8.614 | 0.0008 |
| Iron | 0.1636 | 1.239 | 0.3232 |

B. Discriminant Stepwise selection of Basic Water Quality major cations

| Step Number | Parameter Entry | Partial[3/] $r^2$ | F Value | Prob>F | Wilk's Lambda (F Value) | Pillais' Trace (F Value) |
|---|---|---|---|---|---|---|
| Step 1 | Sodium | 0.9762 | 260.231 | 0.0001 | 260.231 | 260.231 |
| Step 2 | Sodium | 0.9758 | 241.745 | 0.0001 | | |
| | Magnesium | 0.7513 | 18.128 | 0.0001 | 72.059 | 39.571 |
| Step 3 | Sodium | 0.9287 | 73.815 | 0.0001 | | |
| | Magnesium | 0.8640 | 35.989 | 0.0001 | | |
| | Calcium | 0.7490 | 16.908 | 0.0001 | 62.436 | 19.292 |
| Step 4 | Sodium | 0.9297 | 70.491 | 0.0001 | | |
| | Magnesium | 0.9203 | 61.609 | 0.0001 | | |
| | Calcium | 0.7906 | 20.141 | 0.0001 | | |
| | Potassium | 0.6242 | 8.859 | 0.0011 | 56.749 | 18.654 |
| Step 5 | No other parameters entered | | No other significant contributors to the model | | | |

1/ Complete analysis results in Appendix 4-1.5

2/ Selection criteria for entry into discriminant analysis. Iron will not be considered for selection.

3/ Partial $r^2$ value used to test for removal from the next step.

Table 4-9. Summary results for the Analysis of Variance (ANOVA) performed on the Basic Water Quality (BWQ) measurements collected in the Aquatic Monitoring Program.

| Parameter Measured | Model $r^2$ | Source of Variation: Station D.F. | Station F Value | Station PR>F | Report Year D.F. | Report Year F Value | Report Year PR>F | Season D.F. | Season F Value | Season PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| **Major Cations** | | | | | | | | | | |
| Calcium | 0.8969 | 3 | 44.19** | 0.0001 | 1 | 1.13 | 0.3029 | 2 | 2.77 | 0.0925 |
| Magnesium | 0.8574 | 3 | 28.29** | 0.0001 | 1 | 0.33 | 0.5754 | 2 | 5.53* | 0.0150 |
| Sodium | 0.9818 | 3 | 286.39** | 0.0001 | 1 | 0.81 | 0.3814 | 2 | 2.05 | 0.1612 |
| Potassium | 0.6743 | 3 | 9.44** | 0.0008 | 1 | 1.12 | 0.3057 | 2 | 1.85 | 0.1893 |
| **Major Anions** | | | | | | | | | | |
| Bicarbonate | 0.9466 | 3 | 92.85** | 0.0001 | 1 | 0.00 | 0.9799 | 2 | 2.80 | 0.0905 |
| Sulfate | 0.9429 | 3 | 81.09** | 0.0001 | 1 | 9.26** | 0.0077 | 2 | 5.98* | 0.0115 |
| Chloride | 0.6695 | 3 | 10.31** | 0.0005 | 1 | 1.49 | 0.2400 | 2 | 0.01 | 0.9914 |
| Carbonate | 0.4118 | 3 | 2.25 | 0.1217 | 1 | 1.87 | 0.1904 | 2 | 1.29 | 0.3024 |
| **General Parameters** | | | | | | | | | | |
| Total Alkalinity | 0.9650 | 3 | 145.00** | 0.0001 | 1 | 0.11 | 0.7397 | 2 | 3.07 | 0.0742 |
| Total Dissolved Solids | 0.9726 | 3 | 182.89** | 0.0001 | 1 | 4.62 | 0.0472 | 2 | 7.44** | 0.0052 |
| Total Phosphate | 0.3907 | 3 | 1.67 | 0.2130 | 1 | 1.08 | 0.3139 | 2 | 2.08 | 0.1569 |
| Total Suspended Solids | 0.3755 | 3 | 1.39 | 0.3066 | 1 | 1.15 | 0.3114 | 1 | 0.08 | 0.7837 |

* Significant at P>0.05
** Significant at P>0.025

for calcium. The station main effect was highly significant and the Duncan's Multiple Range Test results for calcium indicate that each station is independent and significantly different from the other (Appendix 4-1.6).

The mean magnesium distribution between each of the four sampling locations is presented in Table 4-7. This table shows that Station YC-2 has substantially higher magnesium values than stations CG-1, YC-1, and YC-3. Station YC-2 is located at a highly incised point in the Yellow Creek Drainage. Table 4-8, part B, indicates that magnesium was the second most significant contributor toward the discriminant function for the major cations. Results from the ANOVA (Table 4-9) indicate that magnesium showed significant station and seasonal effects, and a nonsignificant report year effect. The Duncan's Multiple Range Test results (Appendix 4-1.6) for magnesium show that the spring season differs significantly from the other sampling periods, perhaps due to runoff during the spring. Stations YC-1 and YC-3 are not significantly different or independent from each other.

The mean potassium distribution between each of the sampling locations is presented in Table 4-7. This table presents a progressive increase in downstream potassium concentration, and indicates that the overall means for potassium at stations YC-2 and YC-3 may be similar and higher than the upstream stations YC-1 and CG-1. Table 4-8, part B, shows that potassium was the fourth parameter chosen in the discriminant analysis. Potassium contained the least significant F test and the lowest partial $r^2$ value, thus indicating that no other parameters can be entered into the model. The ANOVA summaries for potassium (Table 4-9) indicate that no time effect was significant, and only the station main effect was significant. The Duncan's Multiple Range test results for the station main effect indicate station cohorts above and below the dry segments of Yellow Creek (Appendix 4-1.6).

The distribution shown for sodium (Table 4-7) is similar to that for conductivity (Table 4-3). Sodium concentrations are proportional to the salt content of the water, as measured by the conductivity. The stepwise discriminant function in Table 4-8 indicates that sodium concentrations

were the single most significant and important measurements made in this model. Sodium measurements account for 97% of the measurable change between sampling stations. Results of the ANOVA presented in Table 4-9 indicate that no seasonal or report year main effects are evident for the sodium parameter. Based on the ANOVA and the stepwise discriminant function results, it is evident that sodium is the single most important cation for monitoring water quality variability. Sodium can be used as a reliable indicator of downstream water quality changes in the Yellow Creek Drainage as long as TDS and streambed characteristics are similar.

Data presented in Table 4-7 indicate that bicarbonate increases in concentration downstream from Tract C-a, while carbonate, sulfate, and chloride measurements exhibit multimodal distributions at downstream stations. Bicarbonate concentrations are directly proportional to the sodium and conductivity measurements made concurrently at the sampling locations. The discriminant analysis in Table 4-10, part B, indicates that bicarbonate measurements can explain 92.8% of the anion difference between sampling locations. Table 4-10 further indicates that all four major anions tested were included in the discriminant function model. The chloride and carbonate parameters were included in the discriminant model, but accounted for 42% and 40% of the independent variability (Table 4-10, part B; step 4). These are questionable results and require further examination to adequately explain their inclusion into the model. Table 4-9 shows that the only significant main effect was station for the bicarbonate, sulfate and chloride parameters. All other main effects were nonsignificant; carbonate was not significant for any of the main effects listed. Unlike the cations examined in Table 4-10, the anion analysis indicates a very high variability in distribution and variance around the mean concentrations, which may account for the unusual groupings exhibited in the Duncan's Multiple Range Test results (Appendix 4-1.6). Based on the results presented in Tables 4-9 and 4-10, bicarbonate should be considered the single most important and reliable anion discriminator among aquatic stations. Furthermore, changes in bicarbonate concentrations along with changes in the conductivity and sodium measurements would be a reliable indicator of changes in the salt concentration that could be used to evaluate downstream changes in water quality.

Table 4-10. Summary results of the Stepwise Discriminant Analysis performed to evaluate the major anion variables contributing to change among stations.[1/]

A. Analysis of Covariance entry statistics to the model[2/]

| Parameters | $r^2$ | F Value | Prob>F |
|---|---|---|---|
| Bicarbonate | 0.9280 | 81.661 | 0.0001 |
| Carbonate | 0.2483 | 2.092 | 0.1351 |
| Sulfate | 0.8673 | 41.392 | 0.0001 |
| Chloride | 0.6385 | 11.184 | 0.0002 |

B. Discriminant Stepwise selection of Basic Water Quality major anions

| Step Number | Parameter Entry | Partial[3/] $r^2$ | F Value | Prob>F | Wilk's Lambda (F Value) | Pillais' Trace (F Value) |
|---|---|---|---|---|---|---|
| Step 1 | Bicarbonate | 0.9280 | 81.661 | 0.0001 | 81.661 | 81.661 |
| Step 2 | Bicarbonate | 0.9329 | 83.430 | 0.0001 | | |
| | Sulfate | 0.8763 | 42.504 | 0.0001 | 57.588 | 56.981 |
| Step 3 | Bicarbonate | 0.8951 | 48.354 | 0.0001 | | |
| | Sulfate | 0.8942 | 47.875 | 0.0001 | | |
| | Chloride | 0.4439 | 4.524 | 0.0166 | 36.246 | 11.380 |
| Step 4 | Bicarbonate | 0.9126 | 55.676 | 0.0001 | | |
| | Sulfate | 0.8962 | 46.060 | 0.0001 | | |
| | Chloride | 0.4207 | 3.873 | 0.0294 | | |
| | Carbonate | 0.4008 | 3.567 | 0.0379 | 28.501 | 8.588 |

1/ Complete analysis results presented in Appendix 4-1.5

2/ Selection criteria for entry into model: Carbonate should be eliminated: adjusted F value in Step 4 (Part B) allows entry to model.

3/ Partial $r^2$ value used to test for removal from the next step.

Eight general BWQ parameters were examined for inclusion into the stepwise discriminant analysis. Table 4-7 shows the mean concentrations at each sampling location over two years (1981, 1982). All eight general parameters, listed in Table 4-7, were tested using the analysis of covariance selection technique (Table 4-11, part A). Results presented in Table 4-11, part A, indicate that only total dissolved solids and alkalinity should be utilized in the discriminant function. Table 4-11, part B, further indicates that total suspended solids and total phosphate were marginally significant contributors to the change among sampling stations when the means were adjusted in the discriminant analysis. Ammonia, nitrate, fluoride, and dissolved organic carbon did not pass the selection criteria test and were not included in the discriminant model.

Alkalinity and total dissolved solids exhibit the same distributional pattern, of increasing downstream concentration from Tract C-a, as conductivity, sodium, and bicarbonate (Table 4-7). Both alkalinity and total dissolved solids are directly proportional to the specific conductance of surface waters, and follow the downstream concentration pattern that has been demonstrated herein. Table 4-11, part B, indicates that alkalinity was the single most important general parameter measured, accounting for 97.5% of the station variability. ANOVA results presented in Table 4-9, indicate that alkalinity was highly significant between stations and nonsignificant over the main effects of year and season.

Total dissolved solids (TDS) concentrations appear to be directly proportional to the conductivity of surface waters (Tables 4-3 and 4-7). The same increasing concentration pattern exhibited by the conductivity measurement is seen in the total dissolved solids measurement. TDS was the second most significant contributor to change in the general parameters discriminant function analysis (Table 4-11, part B: Appendix 4-1.5). ANOVA results presented in Table 4-9 indicate that TDS values are significantly different between stations and seasons, and marginally different between reporting years. The Duncan's Multiple Range Test results (Appendix 4-1.6) indicate an overlapping pattern for seasonal TDS values and four independent TDS means for the station range test. Even though the ANOVA

Table 4-11. Summary results of the Stepwise Discriminant Analysis performed to evaluate the general water chemistry parameters contributing to change among stations.[1/]

A. Analysis of Covariance entry statistics to the model[2/]

| Parameters | $r^2$ | F Value | Prob>F |
|---|---|---|---|
| Total Dissolved Solids | 0.9468 | 59.381 | 0.0001 |
| Total Suspended Solids | 0.2822 | 1.310 | 0.3247 |
| Alkalinity | 0.9758 | 134.449 | 0.0001 |
| Total Phosphate | 0.4884 | 3.182 | 0.0717 |
| Ammonia | 0.1535 | 0.604 | 0.6269 |
| Nitrate | 0.2456 | 1.085 | 0.3994 |
| Fluoride | 0.6949 | 7.591 | 0.0062 |
| Dissolved Organic Carbon | 0.6078 | 5.167 | 0.0206 |

B. Discriminant Stepwise selection of Basic Water Quality general parameters.

| Step Number | Parameter Entry | Partial[3/] $r^2$ | F Value | Prob>F | Wilk's Lambda (F Value) | Pillais' Trace (F Value) |
|---|---|---|---|---|---|---|
| Step 1 | Alkalinity | 0.9758 | 134.449 | 0.0001 | 134.449 | 134.449 |
| Step 2 | Alkalinity | 0.9074 | 29.396 | 0.0001 | | |
| | Total Dissolved Solids | 0.7965 | 11.745 | 0.0018 | 39.761 | 24.400 |
| Step 3 | Alkalinity | 0.9583 | 61.235 | 0.0001 | | |
| | Total Dissolved Solids | 0.7882 | 9.922 | 0.0045 | | |
| | Total Suspended Solids | 0.6400 | 4.741 | 0.0348 | 27.269 | 5.148 |
| Step 4 | Alkalinity | 0.9571 | 52.014 | 0.001 | | |
| | Total Dissolved Solids | 0.8313 | 11.500 | 0.0043 | | |
| | Total Suspended Solids | 0.6858 | 5.093 | 0.0352 | | |
| | Total Phosphate | 0.6783 | 4.919 | 0.0381 | 24.819 | 5.392 |
| Step 5 | No other parameters entered | | No other significant contributors to the model | | | |

1/ Complete analysis results presented in Appendix 4-1.5

2/ Selection criteria for entry into model: Ammonia, Nitrate, Fluoride and Dissolved Organic Carbon will not be considered for selection.

3/ Partial $r^2$ value used to test for removal from the next step.

results presented in Table 4-9 indicate a marginally significant report year main effect, the Duncan's Multiple Range Test results indicate that the group means for TDS report year values are not significantly different. This discrepancy is due primarily to the variance around the means overlapping each of the report years. The Statistical Analysis System (SAS) routine (used for this analysis) tests the treatment effects in the ANOVA independent from the means tested in the Duncan's Multiple Range Test.

Total suspended solids and total phosphate were the third and fourth variables entered into the discriminant model (Table 4-11, part B). These two parameters were marginal contributors to the discriminant function. ANOVA results (Table 4-9) indicate that both suspended solids and phosphates were nonsignificant over all the main effects. This discrepancy in results may be due, in part, to the lack of data for suspended solids in the fall sampling period and the bimodel distribution seen in phosphate data (Table 4-7). From this data analysis, total suspended solids and phosphates appear to be unreliable indicators of change in downstream water quality. However, suspended solids and phosphate concentrations may be important factors influencing the productivity of aquatic communities.

## 4.2 BIOTIC COMPONENTS

### A. Periphyton

#### 1. Objectives

The objectives of the periphyton studies are to monitor changes in the community structure and to assess the effects of Tract C-a development on this population. Species composition, density, and diversity are reported for the 1982 sampling season.

#### 2. Methods

The methods used for the identification and enumeration of the periphyton sampled in this program were upgraded from the methods previously described in MDP Report 4 (RBOSC 1978). The Sedgewick-Rafter counting cell, described in the Standard Methods Manual (APHA/AWWA/WPCF 1975) was used to enumerate the periphyton collected at four stations (Figure 4-1). This method of periphyton enumeration was chosen to increase the species richness that may be present in periphyton samples collected near Tract C-a. Six replicate samples were collected from each station during 1982.

Laboratory techniques and procedures for the preparation, identification, and enumeration of periphyton samples, using the Sedgewick-Rafter, are described in standard methods (APHA/AWWA/WPCF 1975). Voucher collections have been maintained to verify results obtained from the 1982 sampling season for periphyton.

Periphyton density data were evaluated for a normal distribution. Log transformation was required to place the periphyton data into the normal distribution required for analysis of variance techniques described below.

Statistical analysis of the log transformed density data was completed using a three-way Model I Analysis of Variance technique. The hypotheses being tested in this model are:

$H_o$: There are no significant differences between report years sampled.

$H_o$: There are no significant differences between the seasons sampled.

$H_o$: There are no significant differences between the stations sampled.

Table 4-12 indicates the ANOVA model used to evaluate the stated null hypothesis. A two-way Model I ANOVA was also used to evaluate the year and season hypotheses at each station.

## 3. Results and Discussion

A total of 173 taxa was identified from the periphyton samples collected during the 1982 field season. Periphyton count data are presented in Appendix 4-2.1. Appendix 4-2.2 lists the periphyton density and species composition data by sampling season for each station surveyed during 1982. Species diversity calculations are presented in Appendix 4-2.3.

Periphyton community structure is influenced by factors such as climate, light, water temperature, current velocity, substrate composition, canopy cover, and water chemistry (Lowe 1974). The strength of the current and the water quality are two of the most important factors influencing the species composition and density in a stream environment (Lowe 1974; Patrick 1977). Sudden increases in the stream flow and spring runoff from snowmelt have been demonstrated to produce short-term changes in the density and community structure of periphyton (Patrick 1974).

Periphyton density estimates were log transformed to normalize the data for input into the ANOVA model (Table 4-12). Results from these two ANOVA's are summarized in Table 4-13. Table 4-13, part A, indicates that variability over time (report year and season) is highly significant. The station main effect in part A, Table 4-13, is nonsignificant. The Duncan's Multiple Range Test results, associated with the significant main effects presented in Table 4-13, show that periphyton densities were significantly higher in 1981 and 1982 than any other sampling year. Furthermore, each

Table 4-12. Three-Way Model I Analysis of Variance Design for the Evaluation of Log Transformed Periphyton Density Estimates.

| Source | df | F-Test | Expected MS. (Model 1) |
|---|---|---|---|
| A. Years | a-1 | A/F | $\sigma^2 + \frac{bc}{a-1} \sum^{a} \alpha^2$ |
| B. Stations (6 stations) | b-1 | B/E | $\sigma^2 + \frac{ac}{b-1} \sum^{b} \beta^2$ |
| C. Seasons (Spring, Summer, Fall) | c-1 | C/D | $\sigma^2 + \frac{ab}{c-1} \sum^{c} \gamma^2$ |
| D. Years x Stations | (a-1)(b-1) | D/G | $\sigma^2 + \frac{c}{(a-1)(b-1)} \sum^{ab} (\alpha\beta)^2$ |
| E. Years x Seasons | (a-1)(c-1) | E/G | $\sigma^2 + \frac{c}{(a-1)(c-1)} \sum^{ac} (\alpha\beta)^2$ |
| F. Stations x Seasons | (b-1)(c-1) | F/G | $\sigma^2 + \frac{a}{(b-1)(c-1)} \sum^{bc} (\beta\gamma)^2$ |
| G. Year x Station x Season | (a-1)(b-1)(c-1) | G/H | $\sigma^2 + \frac{1}{(a-1)(b-1)(c-1)} \sum^{abc} (\alpha\gamma)^2$ |
| H. Error Term | abc(n-1) | | $\sigma^2$ |
| Total | (nabc)-1 | | |

Table 4-13. Summary Results for the Three-way Analysis of Variance (ANOVA) (Part A) and the Two-way ANOVA (Part B) performed to evaluate log transformed periphyton density.

A) Three-way ANOVA

| Dependent Variable | Model $r^2$ | Source of Variation: Report Year DF | Report Year F Value | Report Year PR>F | Season DF | Season F Value | Season PR>F | Station DF | Station F Value | Station PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| Density | 0.2010 | 3 | 82.58** | 0.0001 | 2 | 8.49** | 0.0002 | 3 | 1.79 | 0.1461 |

B) Two-way ANOVA

| Station Dependent Variable | Model $r^2$ | Source of Variation: Report Year DF | Report Year F Value | Report Year PR>F | Season DF | Season F Value | Season PR>F | Report Year * Season DF | Report Year * Season F Value | Report Year * Season PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| Station CG-1 Density | 0.1460 | 3 | 16.99** | 0.0001 | 2 | 10.87** | 0.0001 | 6 | 2.96** | 0.0075 |
| Station YC-1 Density | 0.0037 | 1 | 0.05 | 0.8248 | 2 | 0.37 | 0.6896 | 1 | 0.00 | 0.9792 |
| Station YC-2 Density | 0.0147 | 1 | 3.22 | 0.0738 | 2 | 0.08 | 0.9211 | 2 | 0.32 | 0.7299 |
| Station YC-3 Density | 0.2714 | 3 | 48.21** | 0.0001 | 2 | 4.56** | 0.0109 | 6 | 11.38** | 0.0001 |

1/ Only the main effects are presented for the Three-way ANOVA. Interaction terms are not presented due to low model coefficient of determination values.

* Significant at P>0.05
** Significant at P>0.25

season was shown to be independent from the other (Appendix 4-2.4). The results presented for the three-way ANOVA (Table 4-13: part A) tend to indicate a high degree of variability associated with periphyton density estimates over time. Because there are many ecological and physical factors that are influencing the periphyton community, these results are expected.

Each station was treated independently in a two-way ANOVA to examine the relative change in periphyton densities over time. Table 4-13, part B, shows that each of the four sampling locations behaves differently over time. Stations CG-1 and YC-3 both exhibited significant differences over the report year and season main effects, indicating that a large amount of variability in periphyton density exists at each of these stations. Four years of periphyton density data were used for stations CG-1 and YC-3 (1979-1982). The Duncan's Multiple Range Test results for stations CG-1 and YC-3 indicate that two separate cohorts exist for each of these stations. Report years 1981 and 1982 tend to be grouped into one cohort, while 1979 and 1980 tend to be another cohort (Appendix 4-2.4). Stations YC-1 and YC-2 each exhibited nonsignificant report year and season main effects. The stream physical data presented in Section 4-1 and Appendix 4-1.3 show that 1981 and 1982 field water quality parameters were similar statistically. This fact may help to explain the similarity among periphyton densities evaluated for sampling years 1981 and 1982 at stations YC-1 and YC-2.

Species composition and diversity are discussed below for each station.

a. Station GC-1 - The dominant diatom genus for the entire MDP program has been Achnanthes (primarily A. affinis, A. lanceolata, and A. minutissima). In 1982, species in the genus Navicula exhibited a high degree of species richness in all three sampling seasons (Table 4-14). The Achnanthes and Navicula diatoms are characteristic of high alkalinity, high dissolved oxygen, and medium organic load in streams (Lowe 1974).

Table 4-14. Mean Densities (Units/$mm^2$) of Dominant Algal Species Identified in the Periphyton Samples Collected during the RBOSC MDP Studies (1978-1982) at Station CG-1.

| | SEASON/YEAR | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring | | | | | Summer | | | | | Fall | | | | |
| | 1978 | 1979 | 1980 | 1981 | 1982 1/ | 1978 | 1979 | 1980 | 1981 | 1982 1/ | 1978 | 1979 | 1980 | 1981 | 1982 1/ |
| Achnanthes affinis | . | . | . | . | 12531 | . | . | 567 | 644 | 18593 | . | . | . | 23 | 6562 |
| A. lanceolanta | . | . | 26 | 110 | 15515 | . | . | . | . | . | 158 | . | 2 | . | . |
| A. lanceolata var. dubia | . | . | . | . | | . | . | . | 56 | 593 | . | . | . | 277 | 1937 |
| A. minutissima | . | . | 31 | 74 | 2640 | . | . | . | . | 718 | . | . | 227 | . | 16937 |
| A. species | 94 | 905 | . | . | . | 86 | 5816 | . | . | . | 3864 | 14889 | . | . | . |
| Batrachosperum spp. | . | . | . | . | . | . | . | . | . | 5828 | . | . | 142 | . | 3375 |
| Cymbella minuta | . | . | . | . | 249 | . | . | . | 18 | 796 | . | . | . | . | 15 |
| Fragilaria vacheriae | . | 364 | 41 | 201 | 265 | . | 203 | 201 | . | 1671 | . | . | . | . | 31 |
| Gomphonema intricatum | . | . | . | . | . | . | . | . | . | . | 669 | . | . | . | . |
| G. olivaceum | . | . | . | 22 | 15 | . | . | . | . | 31 | . | . | . | . | . |
| Merdion circulare | . | . | 5 | . | 203 | . | . | . | . | 15 | . | . | . | . | . |
| Navicula arvensis | 25 | . | . | . | 312 | . | . | 1 | . | 109 | . | . | . | . | . |
| N. cryptocephala | 14 | . | 3 | 8 | 218 | 2 | . | . | 32 | 156 | 862 | . | . | 24 | . |
| N. halophila | . | . | . | . | . | . | 19 | . | . | 62 | . | . | . | . | 375 |
| N. heufleri | . | . | . | . | . | . | . | . | . | 296 | . | . | 7 | . | 93 |
| N. pelliculosa | . | . | 2 | . | 7468 | . | . | 1 | 20 | 1984 | 1521 | . | . | . | . |
| N. secreta | . | . | 17 | 74 | 2281 | . | . | 62 | 30 | 3078 | . | . | 20 | 275 | 3531 |
| N. viridula | . | . | 70 | . | 250 | . | . | . | . | 3109 | 744 | . | 26 | . | 250 |
| Nitzschia acicularis | . | . | . | . | 62 | . | . | . | . | 62 | . | . | 1 | . | 15 |
| N. capitellata | 1008 | 23 | . | . | . | . | . | . | . | . | 490 | . | . | . | . |
| N. dissipata | . | . | . | . | 125 | . | . | . | 27 | . | . | . | . | . | . |
| N. frustulum | . | . | 3 | . | 812 | 61 | . | 6 | 712 | 4187 | 213 | . | 9 | 772 | 1484 |
| N. holsatica | . | . | . | 101 | 125 | . | . | . | . | 15 | . | . | . | . | . |
| N. linearis | . | . | . | 21 | 250 | . | . | . | . | 2187 | . | . | . | . | 46 |
| N. palea | . | . | . | . | 781 | . | . | . | . | 2421 | 177 | . | 1 | 34 | 281 |
| Phormidium species | . | 3148 | 61 | . | . | . | . | . | . | 5437 | . | 246 | . | 242 | 1453 |
| Rhopalodia musculus | . | . | . | . | . | . | . | . | 28 | 30 | . | . | . | . | 15 |
| Surirella ovata | . | . | 25 | . | 281 | . | . | 5 | . | 609 | 508 | . | 1 | . | . |
| Synedra minuscula | . | 78 | . | . | 78 | . | . | . | . | . | . | . | . | . | 62 |

1/ Differences in mean densities may be the result of the differences in laboratory analysis technique used. 1982 samples were evaluated using the Sedgwick-Rafter counting cell.

The only non-diatom taxa that was prevalent at station CG-1 during the MDP program (1978-1982) was the blue-green alga Phormidium (Table 4-14). The red-alga Batrachosperum was present in relatively high diensities during the 1982 sampling program in both the summer and fall sampling seasons. Prior to 1982 Batrachosperum was found only once in the fall sampling season during 1980. Batrachosperum is generally able to tolerate a wide range of water quality conditions (Hynes 1970). This genus has been associated with spring-fed streams at higher altitudes (Ward and Dufford 1979).

Diversity calculations, presented in Table 4-15, indicate that the Shannon-Weiner diversity indices for 1982 were higher than those calculated in 1979 and 1981 and similar to the indices calculated in 1978 and 1980. Species evenness values decreased, while richness increased for all three seasons in 1982. The differences in the diversity indices presented in Table 4-15 can probably be attributed to a very high natural variability in the periphyton community at station CG-1.

b. Station YC-1 - The 1982 sampling program at station YC-1 showed a completely different community structure than was seen in 1981. Navicula species (primarily N. pelliculosa and N. secreta) and Achnanthes affinis were the dominant species in the spring runoff season (Table 4-16). Station YC-1 was dry for most of the summer season due to a diversion placed in the stream approximately 2 km upstream in Corral Gulch; thus no summer data exists for 1982. The dominant species in the fall sampling season included members of the Achnanthes, Fragilaria, and Nitzschia genera. Nitzschia frustulum exhibited the highest fall season density of all species sampled at this station, indicating an ability to recolonize after an extended dry period in a habitat that is high in alkalinity and organic loading. Enteromorpha species were a dominant alga in the spring of 1981. In 1982, Enteromorpha species were not found in either the spring or the fall samples.

Species richness was substantially greater in the 1982 spring and fall samples than during those same periods in 1981. This may be a function of

Table 4-15. Comparison of Diversity Indices of Periphyton During RBOSC MDP Studies (1978-1982).

| Station | Season | Index | YEAR 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|
| CG-1 | Spring | Diversity | 2.27 | 1.03 | 2.59 | 1.69 | 2.25 |
| | | Evenness | 0.71 | 0.33 | 0.68 | 0.49 | 0.13 |
| | | Richness | 14 | 23 | 44 | 31 | 62 |
| | Summer | Diversity | | 0.21 | 2.22 | 1.63 | 2.82 |
| | | Evenness | | 0.82 | 0.60 | 0.48 | 0.15 |
| | | Richness | | 13 | 40 | 30 | 73 |
| | Fall | Diversity | 2.77 | 0.20 | 1.45 | 1.67 | 2.18 |
| | | Evenness | 0.67 | 0.09 | 0.48 | 0.54 | 0.13 |
| | | Richness | 17 | 10 | 20 | 22 | 45 |
| YC-1 | Spring | Diversity | | | 1.95 | 2.52 | |
| | | Evenness | | | 0.55 | 0.14 | |
| | | Richness | | | 34 | 54 | |
| | Summer | Diversity | | | 1.84 | | |
| | | Evenness | | | 0.53 | | |
| | | Richness | | | 32 | | |
| | Fall | Diversity | | | 1.74 | 2.17 | |
| | | Evenness | | | 0.48 | 0.12 | |
| | | Richness | | | 38 | 58 | |

Table 4-16. Mean Densitities (Units/$mm^2$) of Dominant Algal Species identified in the Periphyton Samples collected During the RBOSC MDP Studies (1978-1982) at Station YC-1.

| Taxonomic Name | SEASON/YEAR Spring 1981 | Spring 1982[1/] | Summer 1981 | Summer 1982[1/] | Fall 1981 | Fall 1982[1/] |
|---|---|---|---|---|---|---|
| Achnanthes affinis | 6949 | 6984 | 119 | . | 1019 | 421 |
| A. Lanceolata | 622 | 187 | . | . | . | 1078 |
| A. Lanceolata var. dubia | . | 1234 | 111 | . | . | . |
| A. minutissima | 184 | 281 | 76 | . | . | 140 |
| Anabaena species | . | 46 | . | . | . | 62 |
| Bulbochaeta species | . | . | . | . | 1065 | 62 |
| Cocconeis placentula | 152 | 156 | . | . | . | 375 |
| Cyclotella maneghiniana | 1169 | 203 | 27 | . | 80 | 437 |
| Cymbella minuta | 194 | 31 | . | . | . | 15 |
| Diatoma tenue | 430 | 31 | . | . | . | 16 |
| Enteromorpha species | 2472 | . | . | . | . | . |
| Fragilaria capucina | . | 94 | . | . | . | 5328 |
| F. vaucheriae | 1251 | 734 | . | . | . | 63 |
| Gomphonema angustation | . | 734 | . | . | 113 | 1031 |
| Navicula cryptocephala | . | 546 | 102 | . | . | 63 |
| N. heufleri | . | 156 | 29 | . | . | 172 |
| N. notha | . | 234 | 19 | . | 61 | 234 |
| N. pelliculosa | . | 12968 | 135 | . | . | 172 |
| N. secreta | 236 | 1203 | 94 | . | . | 16 |
| Nitzschia frustulum | 271 | 7531 | 925 | . | 1561 | 21250 |
| Rhopalodia musculus | . | 15 | . | . | 88 | 359 |
| Synedra minuscula | 236 | 16 | . | . | . | 172 |

1/ Differences in mean densitites may be due in part to the different laboratory analysis used. 1982 samples were evaluated using the Sedgwick-Rafter Counting Cell.

the enumeration methodology utilized for the 1982 samples. Diversity indices presented in Table 4-15 also show that the spring and fall diversities were much higher in 1982 than in 1981. This is an expected result when consideration is given to the increased species richness and decreased species evenness shown in Table 4-15.

c. Station YC-2 - The sampling program at station YC-2 in 1982 also showed a completely different community structure than was seen in the 1981 sampling season. Bulbochaeta species continued to dominate the summer and fall seasons, but were not identified in the spring season. During the 1981 sampling program, Bulbochaeta species were predominant during all three seasons. Table 4-17 exhibits the mean seasonal densities of dominant algal species sampled at station YC-2. Increased species richness and density is seen in 1982 from the data presented in Table 4-17. Diatom richness increased, with Nitzschia frustulum dominating in all three sampling seasons. Achnanthes affinis and Stigeoclonium tenue exhibited unusually high densities in the spring of 1982, considering that these two species were not found in the spring sample in 1981. Table 4-17 further indicates a wide variation among species sampled and densities calculated over the two years that station YC-2 has been sampled.

Species diversities calculations, presented in Table 4-18, indicate a substantial increase in species diversity and richness, along with a decrease in species evenness. The differences in species composition and diversity (Table 4-17 and Table 4-18) may be due in part to the enumeration methodology that was used in 1982, which favors increased diatom species richness.

d. Station YC-3 - The dominant taxa at station YC-3 continued to be Bulbochaeta species, Achnanthes affinis, Fragilaria capucina, Surirella ovata, and Synedra pulchella. These same species were dominant at station YC-3 in 1981. Station YC-3, near the confluence of the White River on Yellow Creek, is in a heavily shaded and incised segment of Yellow Creek. These habitat conditions, which stretch over several miles upstream of station YC-3, help to keep the water temperatures lower favoring such

Table 4-17. Mean Densitities (Units/$mm^2$) of Dominant Algal Species identified in the Periphyton Samples collected during the RBOSC MDP Studies (1978-1982) at Station YC-2.

| Taxonomic Name | SEASON/YEAR Spring 1981 | Spring 1982[1/] | Summer 1981 | Summer 1982[1/] | Fall 1981 | Fall 1982[1/] |
|---|---|---|---|---|---|---|
| Achnanthes affinis | . | 12078 | 702 | 703 | 245 | 296 |
| A. lanceolata | . | 843 | . | 234 | . | 625 |
| A. hauckiana | . | 171 | 251 | 1781 | 585 | 4359 |
| A. minutissima | 318 | 468 | . | 94 | . | 593 |
| Anabaena species | 388 | 109 | . | 2343 | . | 156 |
| Bulbochaeta species | 5272 | . | 1675 | 31296 | 6357 | 50093 |
| Cocconeis placentula | . | 125 | . | 219 | . | 718 |
| Cyclotella maneghiniana | . | 281 | . | 3703 | . | 328 |
| Cymbella minuta | . | 31 | . | 171 | . | . |
| Diatoma tenue | . | 47 | . | . | . | . |
| Fragilaria capucina | 132 | 2375 | . | 125 | . | 94 |
| F. vaucheriae | . | 203 | . | . | . | 31 |
| Gomphonema angustatun | . | 125 | . | 15 | . | . |
| G. olivacium | . | 906 | . | . | . | 15 |
| G. subclavatum | . | 47 | . | 47 | . | . |
| Navicula arvensis | . | 3094 | . | 94 | . | 265 |
| N. cryptocephala | . | 578 | . | 31 | . | 94 |
| N. heufleri | 80 | 125 | . | 47 | . | 359 |
| N. notha | . | 406 | . | 31 | . | 312 |
| N. pelliculosa | . | 8687 | . | 47 | . | 47 |
| N. secreta | . | 328 | . | . | . | 218 |
| N. viridula | . | . | . | 94 | . | 218 |
| Nitzschia communis | . | 172 | . | 406 | . | 125 |
| N. frustulum | 341 | 4515 | 3118 | 15125 | 1546 | 15187 |
| N. holstatica | 442 | 6656 | . | 250 | . | . |
| N. palea | . | 2250 | . | 3890 | . | 5453 |
| Rhopalodia gibba | 543 | 235 | . | 687 | 220 | 2734 |
| R. musculus | 188 | 31 | . | 265 | . | 3531 |
| Surirella ovata | . | 500 | . | | . | 31 |
| Synedra minuscula | . | 94 | 176 | . | . | . |
| Stigeoclonium tenue | . | 27781 | 1185 | 5516 | . | 234 |

1/ Differences in mean densitites may be due in part to the different laboratory analyses used. 1982 samples were evaluated using the Sedgwick-Rafter Counting Cell.

Table 4-18. Comparison of Diversity Indices of Periphyton During RBOSC MDP Studies (1978-1982).

| Station | Season | Index | YEAR 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|
| YC-2 | Spring | Diversity | | | | 1.41 | 2.25 |
| | | Evenness | | | | 0.44 | 0.13 |
| | | Richness | | | | 24 | 59 |
| | Summer | Diversity | | | | 1.80 | 2.47 |
| | | Evenness | | | | 0.52 | 0.13 |
| | | Richness | | | | 31 | 71 |
| | Fall | Diversity | | | | 1.32 | 1.94 |
| | | Evenness | | | | 0.39 | 0.11 |
| | | Richness | | | | 30 | 56 |
| YC-3 | Spring | Diversity | 1.22 | 1.92 | 2.52 | 1.39 | 2.14 |
| | | Evenness | 0.36 | 0.57 | 0.67 | 0.46 | 0.13 |
| | | Richness | 11 | 29 | 42 | 21 | 43 |
| | Summer | Diversity | 0.74 | 1.50 | 1.69 | 1.19 | 1.91 |
| | | Evenness | 0.27 | 0.43 | 0.50 | 0.36 | 0.11 |
| | | Richness | 7 | 33 | 29 | 28 | 64 |
| | Fall | Diversity | 3.25 | 0.65 | 1.05 | 1.78 | 1.94 |
| | | Evenness | 0.76 | 0.22 | 0.34 | 0.51 | 0.11 |
| | | Richness | 18 | 19 | 22 | 33 | 48 |

species as Surirella ovata (Round 1973). Based on the density data presented in Table 4-19, the spring and fall periphyton communities at station YC-3 are dominated by a diverse group of diatoms whose abundance and composition varies both seasonally and annually. Total periphyton densities were higher at station YC-3 in 1982 than other years. This, again, may be due in part to the change in enumeration methodology.

Species diversity calculations for station YC-3 were higher in the spring of 1982 than in 1978, 1979, and 1981, but were lower than diversity estimates calculated for 1980 (Table 4-18). Summer and fall diversity estimates were higher in 1982 than most other MDP sampling years. Species richness was substantially higher in 1982 than all other years.

In summary, the periphyton densities were greater at all four sampling stations in 1982, but were not statistically different from the data collected in 1981. Periphyton densities were, however, significantly different in 1982 from the data collected in 1979 and 1980. The red alga, Batrachospermum, along with various diatoms (Achnanthes, Navicula, Nitzschia) continued to dominate station CG-1. At station YC-3, total periphyton densities were higher in 1982 over 1979, 1980 and 1981 values. The green alga Bulbochaeta species also displayed a continued dominance in the periphyton community during the summer and fall sampling seasons at station YC-3. The variations and changes seen in the periphyton communities, at each station, cannot be explained as seasonal variations. Climatic conditions and local short-term changes, such as flow variability, may be affecting these communities.

Table 4-19. Mean Densities (Units/$mm^2$) of Dominant Algal Species Identified in the Periphyton Samples Collected during the RBOSC MDP Studies (1978-1982) at Station YC-3.

| | SEASON/YEAR | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring | | | | | Summer | | | | | Fall | | | | |
| | 1978 | 1979 | 1980 | 1981 | 1982[1/] | 1978 | 1979 | 1980 | 1981 | 1982[1/] | 1978 | 1979 | 1980 | 1981 | 1982[1/] |
| Achnanthes affinis | . | . | . | 2538 | 10015 | . | . | 866 | 579 | 781 | . | . | 2927 | 435 | 2468 |
| A. lanceolanta | . | . | 4 | . | 312 | . | . | . | . | 906 | . | . | . | . | 62 |
| A. hauckiana | . | . | . | . | . | . | . | . | . | 1562 | . | . | . | . | . |
| A. minutissima | 6226 | . | 22 | . | . | 86 | . | 13 | . | 265 | 49 | 478 | . | . | 875 |
| Anabaena species | . | . | . | . | . | . | . | . | . | 890 | . | . | . | . | . |
| Bulbochaeta species | . | . | . | 1467 | 16375 | . | 72 | 1583 | 3448 | 67765 | . | . | 1190 | 4011 | 41906 |
| Cocconeis placentula | . | . | . | 90 | 15 | . | . | . | . | . | . | . | . | . | . |
| Cyclotella meneghiniana | . | . | . | . | 203 | 18 | 15 | 443 | . | 8453 | 117 | . | 103 | 83 | 578 |
| Cymbella minuta | . | . | . | 301 | 218 | 13 | . | . | . | 1436 | . | . | 74 | . | 543 |
| Diatoma tenue | . | . | . | . | 31 | . | . | . | . | . | . | . | . | . | . |
| D. vulgare | . | . | . | . | 62 | . | . | . | . | . | . | . | . | . | . |
| Fragilaria capucina | . | . | 19 | . | 468 | . | . | . | . | . | . | . | . | . | 16 |
| F. vaucheriae | 10 | 262 | 35 | . | 2796 | . | . | . | . | 516 | . | . | . | . | 281 |
| Gomphonema angustatum | . | . | . | . | 78 | . | . | . | . | 63 | . | . | . | . | 781 |
| G. gracile | . | . | . | . | 172 | . | . | . | . | . | . | . | . | . | . |
| G. olivacium | . | 35 | 1 | . | 218 | . | . | . | . | 16 | . | . | . | . | . |
| G. parvulum | . | . | . | . | 16 | . | . | . | . | 93 | . | . | . | . | 16 |
| Navicula arvensis | . | . | . | . | 109 | . | . | . | . | 31 | . | . | . | . | . |
| N. atomus | . | . | . | . | 2093 | . | . | . | . | . | . | . | . | . | . |
| N. cincta | . | . | . | . | 140 | . | . | . | . | 78 | . | . | . | . | 47 |
| N. cryptocephala | . | . | 7 | . | 47 | 2 | . | . | . | 2328 | 6 | . | . | . | 1124 |
| N. halophila | . | . | . | . | 234 | . | . | . | . | 531 | . | . | . | . | 765 |
| N. pelliculosa | 21965 | 729 | 24 | . | 14875 | . | . | . | . | 406 | . | . | . | . | 16 |
| N. salinarum | . | . | . | . | 140 | . | . | . | . | 218 | . | . | . | . | . |
| N. secreta | . | . | 8 | . | 156 | . | . | 4 | 56 | 187 | 119 | . | . | . | 172 |
| Nitzschia frustulum | 1635 | . | 1 | . | 4953 | 61 | 22 | 11 | 224 | 9562 | 295 | . | 52 | 558 | . |
| N. microcephala | . | 355 | . | . | 375 | 27 | 2 | . | . | 437 | 97 | . | . | . | 921 |
| N. palea | 909 | . | 9 | . | 953 | . | . | . | . | 2609 | 33 | . | . | . | 8796 |
| N. romana | . | 232 | 2 | . | 16 | . | . | . | . | 265 | . | . | . | . | 172 |
| Rhopalodia gibba | . | . | . | . | . | . | . | . | . | 78 | . | . | . | . | . |
| R. musculus | . | . | . | . | 31 | . | . | . | 151 | 469 | . | . | . | 876 | . |
| Surirella ovalis | . | . | . | . | 1313 | . | . | . | . | 1672 | 43 | . | 9 | . | 562 |
| S. ovata | 52 | 280 | 68 | 212 | 6688 | . | . | . | . | 188 | . | . | . | . | 796 |
| Synedra fasciculata | . | . | . | . | 16 | . | . | . | . | . | . | . | . | . | 63 |
| S. pulchella | 2 | 26 | 148 | . | 94 | . | 4 | 344 | . | 2703 | . | . | . | 540 | 5125 |
| Sprirogra species | . | . | . | . | . | . | . | . | . | 671 | . | . | . | . | . |
| Stigeoclonium tenue | . | . | . | . | . | . | . | . | . | 31 | . | . | . | . | . |

1/ Differences in mean densities may be the result of the differences in laboratory analyses used. 1982 samples were evaluated using the Sedgwick-Rafter counting cell.

B. Benthos

1. Objectives

Data on benthos taxonomic composition, density, and diversity are collected to permit the evaluation of the effects of development activity on benthos. Benthic macroinvertebrates constitute the major component of the secondary trophic level in aquatic ecosystems on and near Tract C-a. Their limited mobility and well-documented susceptibility to physical and chemical changes in their environment make macroinvertebrates a very important element of the MDP Monitoring Program (Kolkowitz and Marsson 1909; Hynes 1960; Tarzwell 1965; Cairns and Dickson 1973; Hart and Fuller 1974; Hilsenhoff 1977; Beck 1977; Hubbard and Peters 1978; Harris and Lawrence 1978; Surdick and Gaufin 1978).

2. Methods

The methods used for the identification and enumeration of benthic macroinvertebrates collected in this program are described in Standard Methods (APHA-AWWA-WPCF 1975). Various improvements were made in the quality control of data recorded in the laboratory, including lower level taxonomic verification. Independent and random review of identification and replicate counts, both within the contract laboratory and by independent taxonomists, were made this past year.

Statistical evaluation of the benthic macroinvertebrate density data was completed using two ANOVA techniques. A two-way ANOVA was used to examine the overall change in density at each station sampled. The following hypotheses were evaluated using this technique:

$H_o$: There was no significant difference, at each station, in benthic macroinvertebrate densities between reporting years.

$H_o$: There was no significant difference, at each station, in benthic macroinvertebrate densities between sampling seasons.

Table 4-20 shows the ANOVA model used to examine these hypotheses.

Table 4-20. Two-Way Model I Analysis of Variance used to evaluate log transformed Benthic Macroinvertebrate density estimate.

| Source | df | F-Test | Expected MS. |
|---|---|---|---|
| A. Years | a-1 | A/C | $\sigma^2 + \frac{b}{a-1} \Sigma \alpha^2$ |
| B. Seasons | b-1 | B/C | $\sigma^2 + \frac{a}{b-1} \Sigma \beta^2$ |
| C. Years x Seasons | (a-1)(b-1) | C/D | $\sigma^2 + \frac{1}{(a-1)(b-1)} \Sigma\alpha\beta^2$ |
| D. Error | ab(n-1) | | $\sigma^2$ |
| Total | (abn)-1 | | |

A three-way Model 1 ANOVA without interaction, similar to that shown in Table 4-2, was used to evaluate the changes over years, seasons, and stations for a selected set of higher level taxa.

## 3. Results and Discussion

Forty-six benthic macroinvertebrate taxa were identified from samples collected at four stations in 1982. Count data and species composition for each station are presented in Appendix 4-2.5. Appendix 4-2.6 presents the seasonal species composition and density at each station. Table 4-21 summarizes the species composition and density at each station sampled in 1982. Density and diversity index calculations for each station and season are provided in Appendix 4-2.7.

TABLE 4-21. MEAN MACROINVERTEBRATE SPECIES DENSITIES SAMPLED IN 1982, OVER THREE SEASONS AND FOUR STATIONS

| TAXONOMIC NAME | CG-1 | | | YC-1 | | | YC-2 | | | YC-3 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPRING | SUMMER | FALL | SPRING | SUMMER | FALL | SPRING | SUMMER | FALL | SPRING | SUMMER | FALL |
| ACARI SPECIES | . | 19.20 | . | . | . | . | 19.20 | 12.80 | 6.40 | . | 64.00 | . |
| AGABUS SPECIES | . | . | . | 217.6 | . | . | 19.20 | . | . | 38.40 | 64.00 | . |
| AMPHIAGRION SELYS | . | . | . | . | . | . | 57.60 | 6.40 | 38.40 | . | . | . |
| ANAX WALSINGHAM | . | . | . | . | . | . | 38.40 | 12.80 | . | . | . | . |
| ARGIA SPECIES | . | . | . | . | . | . | 6.40 | . | . | . | 32.00 | 12.80 |
| BAETIS INSIGNIFICANS | . | 1082 | 57.60 | 25.60 | . | . | . | . | . | . | . | . |
| BAETIS TRICAUDATUS DODDS | 19.20 | 601.6 | 236.8 | 1126 | . | . | 19.20 | . | . | 6.40 | 32.00 | . |
| CALLIBAETIS SPECIES | . | 19.20 | 6.40 | . | . | 6.40 | 6.40 | 601.6 | 51.20 | . | . | . |
| FAMILY CAPNIIDAE | . | 6.40 | 153.6 | . | . | . | . | . | . | . | . | . |
| CHELIFERA MACQUART | 6.40 | 6.40 | . | . | . | . | . | . | . | . | . | . |
| CHIRONOMIDAE PUPAE | 32.00 | 51.20 | 32.00 | 2752 | . | 32.00 | 448 | 76.80 | . | 588.8 | 83.20 | 32.00 |
| TRIBE CHIRONOMINI | 12.80 | 25.60 | . | . | . | 25.60 | 83.20 | 416 | 108.8 | . | 25.60 | 6.40 |
| TRIBE CORYNONEURINI | . | 32.00 | . | . | . | . | . | . | . | . | . | . |
| DERONECTES SPECIES | . | . | . | . | . | . | 19.20 | . | 6.40 | 32.00 | 32.00 | . |
| TRIBE DIAMESINI | . | . | . | . | . | . | . | . | . | 1139 | . | . |
| DICRANOTA SPECIES | . | 6.40 | . | . | . | . | . | . | . | . | . | . |
| ENALLAGMA SPECIES | . | . | . | . | . | . | 32.00 | 70.40 | 25.60 | . | . | . |
| EUPARYPHUS SPECIES | . | . | . | . | . | . | . | . | . | . | 6.40 | . |
| HALIPLUS SPECIES | . | . | . | . | . | . | . | 12.80 | 6.40 | . | . | . |
| HAPLOTAXIS GORDIOIDES | 25.60 | 44.80 | . | . | . | . | . | . | . | . | . | . |
| HELOBDELLA STAGNALIS | . | 12.80 | . | . | . | . | 307.2 | 345.6 | 224 | 25.60 | . | 19.20 |
| HEMERODROMIA SPECIES | . | . | . | . | . | . | . | . | . | . | 6.40 | . |
| HYALELLA AZTECA SAUSSURE | . | . | 64.00 | . | . | 12.80 | 4365 | 1203 | 6586 | 19.20 | 6.40 | 6.40 |
| HYDROPSYCHE SPECIES | . | . | . | . | . | . | . | . | . | . | 12.80 | 32.00 |
| HYDROPTILA SPECIES | . | 6.40 | . | 12.80 | . | . | . | . | 25.60 | . | 38.40 | . |
| ISCHNURA SPECIES | . | . | . | . | . | 6.40 | . | 38.40 | . | . | . | . |
| LACCOBIUS SPECIES | . | . | . | . | . | . | . | 12.80 | . | . | 12.80 | . |
| LIMNOPHORA ROBINEAU-DESO | . | 64.00 | 6.40 | . | . | 89.60 | . | . | 25.60 | . | 6.40 | . |
| LIMNEPHILUS SPECIES | . | . | . | . | . | . | 19.20 | . | . | . | . | . |
| LYMNAEA SPECIES | . | . | . | . | . | . | 224 | 6.40 | 6.40 | . | . | . |
| TRIBE MACROPELOPIINI | . | 1082 | 32.00 | . | . | 108.8 | . | 1594 | . | . | 281.6 | 51.20 |
| TRIBE METRIOCNEMINI | . | . | . | . | . | 12.80 | . | . | . | . | 64.00 | . |
| NAIS SPECIES | 12.80 | 134.4 | . | . | . | . | . | 1030 | . | . | 147.2 | . |
| PHYLUM NEMATODA | . | . | . | 25.60 | . | . | . | . | . | 6.40 | . | . |
| OPHIOGOMPHUS SEVERUS | . | . | . | . | . | . | . | . | . | . | 6.40 | . |
| TRIBE ORTHOCLADIINI | 64.00 | 396.8 | 38.40 | 16973 | . | 51.20 | 902.4 | . | . | 678.4 | 32.00 | 51.20 |
| PALPOMYIA GP. SPECIES ME | . | . | 6.40 | 12.80 | . | . | 89.60 | 6.40 | 121.6 | 499.2 | 25.60 | 6.40 |
| TRIBE PENTANEURINI | . | 6.40 | . | 691.2 | . | 19.20 | 364.8 | 70.40 | . | 19.20 | 76.80 | 12.80 |
| FAMILY PERLODIDAE | . | 6.40 | . | . | . | . | . | . | . | . | . | . |
| SIMULIUM SPECIES | 6.40 | 1446 | 19.20 | 12262 | . | 518.4 | 8070 | 38.40 | 825.6 | 204.8 | 3558 | 332.8 |
| TABANUS SPECIES | . | . | . | 25.60 | . | . | 12.80 | 6.40 | . | 6.40 | . | . |
| TRIBE TANYTARSINI | . | . | . | . | . | 115.2 | 51.20 | 640 | 89.60 | 19.20 | 108.8 | 6.40 |
| FAMILY THAUMALEIDAE | . | . | . | . | . | . | . | . | . | 6.40 | . | . |
| FAMILY TIPULIDAE | . | . | . | 6.40 | . | . | . | . | . | . | . | . |
| FAMILY TUBIFICIDAE | 38.40 | 294.4 | . | 108.8 | . | 6.40 | 6752 | 3859 | 38.40 | 1190 | 992 | 128 |
| ZAPADA CINCTIPES | . | 12.80 | . | . | . | . | . | . | . | . | . | . |

The benthic macroinvertebrate community structure in the Yellow Creek drainage system is influenced primarily by flow, water temperature and dissolved oxygen. Most of the species listed in Table 4-21 are able to tolerate a wide range of conductivity, such as that reported in this section. Current velocity, and subsequently turbidity, have been demonstrated to influence the community structure of macroinvertebrates in spring runoff and summer limnological conditions (Pennak 1974; Wilber 1974). Simulium (Diptera:Simuliidae) species was the only taxa observed at each station and during each season in 1982 (Table 4-21). Simuliids tend to inhabit streams with constant and uninterrupted flow conditions (Merritt and Cummins 1978). The habitat conditions were relatively stable in 1982, with the exception of station YC-1 being dry in the summer season.

Benthic macroinvertebrate density data were tested for a normal distribution. These data were log transformed to produce a normal distribution. Results of the two different ANOVA techniques are summarized in Tables 4-22 and 4-23. The two-way ANOVA, by individual stations, indicated no significant change in density over time for any of the four stations sampled (report year x season interaction: Table 4-22). This analysis did indicate that individual components within the model produced a significant result. Density estimates at station CG-1 were significantly different among reporting years (Appendix 4-2.8). Station YC-1 exhibited a significant seasonal main effect (Table 4-22), probably because the station was dry during the summer season. Station CG-1, on the eastern edge of Tract C-a, is influenced by changes in flow conditions and spring runoff, because of its location at the confluence with Box Elder Gulch

Results from the three-way ANOVA, without interaction, for a selected set of higher level taxonomic groupings is presented in Table 4-23. The Phylum Nematoda was purposely left out of this analysis because of the small data set that exists for this major taxa. This analysis is very specific in that each of the taxa listed are subjected to the rigorous assumptions outlined for ANOVA. This model was run without interaction to evaluate the independent behavior of each main effect for each of the taxa listed. Of the taxa listed, only the Class Oligochaeta, Orders Coleoptera and

Table 4-22. Summary Analysis of Variance Statistics for Log Transformed Benthic Macroinvertebrate Density Data by Stations Sampled.

| Station Density | Model $r^2$ | Source of Variation: Report Year DF | Report Year F Value | Report Year PR>F | Season DF | Season F Value | Season PR>F | Report Year * Season DF | Report Year * Season F Value | Report Year * Season PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| CG-1 Density | 0.1465 | 3 | 3.60** | 0.0153 | 2 | 2.18 | 0.1170 | 6 | 1.16 | 0.3295 |
| YC-1 Density | 0.1567 | 1 | 1.63 | 0.2068 | 2 | 3.53** | 0.0359 | 1 | 1.91 | 0.1727 |
| YC-2 Density | 0.0213 | 1 | 0.44 | 0.5089 | 2 | 0.01 | 0.9920 | 2 | 0.84 | 0.4345 |
| YC-3 Density | 0.0505 | 3 | 1.20 | 0.3100 | 2 | 0.08 | 0.9240 | 6 | 0.81 | 0.5650 |

* Significant at P>0.05
** Significant at P>0.025

Table 4-23. Summary Analysis of Variance Statistics for Log Transformed Benthic Macroinvertebrate Data, by Major Taxonomic groupings.

| Major Taxa Density | Model $r^2$ | Source of Variation: Report Year DF | Report Year F Value | Report Year PR>F | Season DF | Season F Value | Season PR>F | Station DF | Station F Value | Station PR>F |
|---|---|---|---|---|---|---|---|---|---|---|
| Class Oligochaeta Density | 0.4739 | 3 | 7.36** | 0.0005 | 2 | 1.80 | 0.1783 | 3 | 2.85* | 0.0501 |
| Order Ephemeroptera Density | 0.2439 | 3 | 0.11 | 0.9555 | 2 | 2.42 | 0.1099 | 3 | 0.97 | 0.4213 |
| Order Odonata Density | 0.1731 | 1 | 0.28 | 0.6050 | 2 | 0.33 | 0.7243 | 2 | 0.78 | 0.4786 |
| Order Plecoptera Density | 0.8601 | 3 | 3.21 | 0.2463 | 1 | 2.67 | 0.2441 | . | . | . |
| Order Coleoptera Density | 0.2882 | 3 | 2.92* | 0.0523 | 2 | 0.17 | 0.8460 | 3 | 0.62 | 0.6099 |
| Order Tricoptera Density | 0.5118 | 3 | 4.06** | 0.0253 | 2 | 1.83 | 0.1929 | 3 | 0.31 | 0.8157 |
| Family Chironomidae Density | 0.2375 | 3 | 4.00** | 0.0092 | 2 | 4.27** | 0.0158 | 3 | 7.59** | 0.0001 |
| Phylum Arthorpoda Density | 0.6719 | 3 | 0.34 | 0.7993 | 2 | 0.09 | 0.9176 | 3 | 2.34 | 0.0758 |

* Significant at P>0.05
** Significant at P>0.025

Tricoptera, and the Family Chironomidae exhibited significant main effects. Density estimates grouped into the Class Oligochaeta exhibited a significant report year and station effect. Most members of this class are euryhaline and can tolerate significant changes in the conductivity and flow in a stream environment; thus, it is difficult to determine why members of this group vary over years and stations. Differences in the depth of bottom sediment and silt substrate can effect the count data collected. The Duncan's Multiple Range test results for this group indicated that station YC-2 had a significantly higher density of the Oligochaeta than all other stations (Appendix 4-2.8). Station YC-2 has a silt bottom with a large amount of fine material, which may be a better habitat for members of this class.

Density estimates grouped under the Orders Coleoptera and Tricoptera each produced significant changes in density over report years. Such changes over time for these orders may be attributed to the qualities of habitat present in the spring for reproduction. Members of these orders are found in all three seasons of the year in the aquatic environment sampled. When sampled, most of these species have just reproduced and are in a pre-adult stage of development. Only the Coleoptera have aquatic adult stages, and both orders generally reproduce in the spring season.

The Chironomidae showed a significant change over years, seasons, and stations (Table 4-23). This group is both diverse in composition and exhibits a wide variation in calculated densities (Table 4-24; RBOSC 1982a). The Duncan's Multiple Range tests for the Chironomidae indicate that station CG-1 has a significantly lower density than the other three stations (Appendix 4-2.8). Differences in the physical conditions outlined in Table 4-3 and Appendix 4-1.1 may help to explain this significance.

Species composition and diversity are discussed below for each station.

a. Station CG-1 - In 1982, the mean benthic macroinvertebrate densities were much higher than those recorded for the major taxa in 1979 and 1981 (Table 4-24; RBOSC 1982a). Members of the Phylum Arthropoda

TABLE 4-24. MEAN DENSITIES FOR MAJOR BENTHIC MACROINVERTEBRATE TAXA OBSERVED DURING THE RBOSC AQUATIC STUDIES IN 1982

| MAJOR TAXA | STATION CG-1 | STATION YC-1 | STATION YC-2 | STATION YC-3 |
|---|---|---|---|---|
| SEASON= FALL | | | | |
| CLASS OLIGOCHAETA | . | 6.40 | 38.40 | 128.00 |
| ORDER EPHEMEROPTERA | 100.27 | 6.40 | 51.20 | . |
| ORDER ODONATA | . | . | 32.00 | . |
| ORDER PLECOPTERA | 153.60 | . | . | . |
| ORDER COLEOPTERA | . | . | 78.93 | 19.20 |
| ORDER TRICOPTERA | . | . | 25.60 | 32.00 |
| FAMILY CHIRONOMIDAE | 34.13 | 52.11 | 99.20 | 26.67 |
| PHYLUM ARTHROPODA | 24.00 | 156.80 | 1261.87 | 89.60 |
| SEASON= SPRING | | | | |
| PHYLUM NEMATODA | . | 25.60 | . | 6.40 |
| CLASS OLIGOCHAETA | 25.60 | 108.80 | 6752.00 | 1190.40 |
| ORDER EPHEMEROPTERA | 19.20 | 576.00 | 12.80 | 6.40 |
| ORDER ODONATA | . | . | 44.80 | . |
| ORDER COLEOPTERA | . | . | 163.20 | 28.80 |
| ORDER TRICOPTERA | 25.60 | 19.20 | 16.00 | 6.40 |
| FAMILY CHIRONOMIDAE | 36.27 | 6805.33 | 369.92 | 488.96 |
| PHYLUM ARTHROPODA | 6.40 | 4164.27 | 1604.00 | 190.40 |
| SEASON= SUMMER | | | | |
| CLASS OLIGOCHAETA | 214.40 | . | 2444.80 | 569.60 |
| ORDER EPHEMEROPTERA | 567.47 | . | 601.60 | 32.00 |
| ORDER ODONATA | . | . | 38.40 | . |
| ORDER PLECOPTERA | 6.40 | . | . | . |
| ORDER COLEOPTERA | 12.80 | . | 179.20 | 32.00 |
| ORDER TRICOPTERA | 21.33 | . | 6.40 | 25.60 |
| FAMILY CHIRONOMIDAE | 265.60 | . | 559.36 | 96.00 |
| PHYLUM ARTHROPODA | 308.48 | . | 166.40 | 419.56 |

exhibited the widest variation in density data over years and seasons at station CG-1: the highest density was recorded in the fall of 1980 (RBOSC 1982a) while 1982 densities were substantially lower for the fall season (Table 4-24). In the 1982 spring sampling season, the Tribe Orthocladiini was the dominant taxa at station CG-1; Simulium species (Simuliidae) dominated the summer season, while Baetis tricaudatus (Baetidae) was dominant in the fall season (Table 4-21). All of these organisms have a high fecundity rate and short life cycle, characteristics that are perhaps largely responsible for their dominance at a station subjected to fluctuations in environmental conditions from two different feeder drainages. Over the entire MDP sampling program (1978-1982), the Ephemeroptera have consistently been the dominant higher level taxanomic group (Table 4-24; RBOSC 1982a).

Diversity calculations for stations CG-1 and YC-1 in the 1982 sampling season are reported in Table 4-25. Station CG-1 had consistently higher diversity indices in 1982 than for 1981. Species richness and diversity were higher in the summer season of 1982 than any other MDP sampling season at station CG-1. Diversity indices are used to reflect gross changes in the species population and community structure. Over time and season, diversity indices at station CG-1 have been variable. Changes in these indices during the summer sampling season may be somewhat reflective of the survival of macroinvertebrates in the harsh spring runoff conditions that are at times seen at this station.

b. Station YC-1 - In 1982, the mean benthic macroinvertebrate densities were substantially higher for some of the major taxa reported in 1981. The Chironomidae exhibit the greatest density change at this station between years and seasons sampled . Spring species composition is dominated by the Orthocladiini, Simulium species (Simuliidae), Chironomidae, and Baetis tricaudatus (Baetidae) (Table 4-21). Station YC-1 was dry in the summer season, hence no data was collected. The fall season was dominated by the Simuliidae. The fall species composition at station YC-1 showed signs of recovery from the summer dry stream bed impact, with thirteen taxa identified in the fall sample.

Table 4-25. Comparison of Diversity Indices of Benthic Macroinvertebrates During RBOSC MDP Studies (1978-1982).

| Station | Season | Index | YEAR 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|
| CG-1 | Spring | Diversity | 2.47 | 2.06 | 1.51 | 1.71 | 1.95 |
| | | Evenness | 0.92 | 0.94 | 0.78 | 0.74 | 0.20 |
| | | Richness | 7 | 9 | 7 | 10 | 9 |
| | Summer | Diversity | 0.86 | 1.02 | 0.85 | 1.24 | 2.00 |
| | | Evenness | 0.67 | 0.57 | 0.37 | 0.90 | 0.14 |
| | | Richness | 2 | 6 | 10 | 4 | 22 |
| | Fall | Diversity | 0.96 | 1.47 | 1.85 | 1.28 | 1.95 |
| | | Evenness | 0.35 | 0.64 | 0.80 | 0.62 | 0.18 |
| | | Richness | 8 | 10 | 8 | 8 | 12 |
| YC-1 | Spring | Diversity | | | 2.06 | 1.18 | |
| | | Evenness | | | 0.76 | 0.10 | |
| | | Richness | | | 15 | 13 | |
| | Summer | Diversity | | | 1.33 | | |
| | | Evenness | | | 0.96 | | |
| | | Richness | | | 4 | | |
| | Fall | Diversity | | | 0.92 | 1.68 | |
| | | Evenness | | | 0.32 | 0.15 | |
| | | Richness | | | 17 | 13 | |

Diversity indices at station YC-1 were lower in the spring of 1982 than those reported for the 1981 spring season (Table 4-25). Species evenness was substantially lower in the spring, due to the dominance of Orthocladiini and Simuliidae taxa in the spring (Tables 4-21 and 4-25). Species richness was lower in the spring and fall of 1982 than reported for 1981. There was no spring or fall difference in the species richness at this site; however, diversity and evenness were greater in the fall. This suggests that the benthic community recovered to a healthy population after the dry conditions, and that a stable flow regime may exist in this part of Yellow Creek when water is present.

c. Station YC-2 - Mean benthic invertebrate densities were lower in the spring and consistently greater in the summer and fall of 1982 than reported for the same seasons in 1981 (Tables 4-24; RBOSC 1982a). Arthropods continued to dominate the spring season; the summer and fall seasons were dominated by the Oligochaeta (Table 4-24). The faunal community at station YC-2 is different from the two upstream sites (stations CG-1 and YC-1). A dominating coexistence is seen between the Oligochaetes (Tubificidae), Simuliidae, and Talitridae in the spring 1982 samples. Tubificidae, Talitridae (Hyalella species), and Naididae (Nais species) were dominant in the summer of 1982, and the Talitridae (Hyalella azteca) dominated the fall samples. Members of the Odonata and Gastropoda have been consistently encountered at this station; their presence suggests that relatively stable habitat conditions exist at station YC-2, since Odonates have a relatively longer life cycle and little evidence exists for unusual changes in the physical makeup of this station.

Data on Table 4-26 indicate that the diversity and richness indices were greater in the spring and summer of 1982 than reported for the same seasons in 1981 at station YC-2. Species diversity and evenness were much lower in the fall of 1982, while the richness remained essentially the same as was reported for 1981 (Table 4-26). This reduction in diversity may be explained by the increased density of Hyalella azteca (Talitridae) in the fall sample.

Table 4-26. Comparison of Diversity Indices of Benthic Macroinvertebrates During RBOSC MDP Studies (1978-1982).

| Station | Season | Index | YEAR 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|
| YC-2 | Spring | Diversity | | | | 1.47 | 1.57 |
| | | Evenness | | | | 0.56 | 0.12 |
| | | Richness | | | | 14 | 22 |
| | Summer | Diversity | | | | 0.96 | 1.94 |
| | | Evenness | | | | 0.37 | 0.15 |
| | | Richness | | | | 13 | 21 |
| | Fall | Diversity | | | | 1.29 | 0.83 |
| | | Evenness | | | | 0.45 | 0.06 |
| | | Richness | | | | 18 | 16 |
| YC-3 | Spring | Diversity | 2.65 | 1.66 | 1.57 | 0.79 | 1.85 |
| | | Evenness | 0.69 | 0.86 | 0.81 | 0.33 | 0.15 |
| | | Richness | 15 | 8 | 7 | 11 | 16 |
| | Summer | Diversity | 3.16 | 0.82 | 0.93 | 0.89 | 1.45 |
| | | Evenness | 0.81 | 0.29 | 0.52 | 0.36 | 0.10 |
| | | Richness | 15 | 16 | 6 | 14 | 124 |
| | Fall | Diversity | 1.41 | 1.84 | 0.82 | 1.50 | 1.74 |
| | | Evenness | 0.48 | 0.68 | 0.45 | 0.57 | 0.15 |
| | | Richness | 8 | 15 | 6 | 15 | 13 |

d. Station YC-3 - Mean densities for major benthic taxa were consistently greater in 1982 than in 1981, and somewhat lower in the fall of 1982 than in the fall of 1980 (Table 4-24; RBOSC 1982a). Mean densities in 1979 (RBOSC 1982a) were lower than those reported for 1982 (Table 4-24) in all three sampling seasons. Chironomids continued to dominate the spring season samples, while Simulium species (Simuliidae) continued to dominate the summer samples (Table 4-21). Tubificidae species dominated the fall samples in 1981; 1982 fall samples shifted to the Simuliidae species being the most prevalent taxa. Over the entire MDP program, there appears to have been no major change in the taxonomic composition, when compared to baseline data presented for this station in MDP Monitoring Report 9 (RBOSC 1982).

Species diversity indices have been quite variable for this station during the MDP program (Table 4-26). Diversity calculations were higher in 1982 than those diversities that were reported for the three sampling seasons in 1981. Species richness was the largest it has been in the spring and summer seasons during the MDP program. Species evenness was consistently lower in 1982 as compared to the other sample periods presented in Table 4-26. Increased density and dominance of the Chironomidae and Simuliidae species in 1982 would tend to drop the species evenness index.

In summary, the four locations sampled in 1982 could be classified into two cohorts based upon macroinvertebrate data. The first cohort consists of stations CG-1 and YC-1: streams with benthic fauna which appear to be affected by variable water quality and flow conditions. The second cohort includes the lower Yellow Creek Stations, YC-2 and YC-3: a hydrologically more stable system, stressed primarily by naturally occurring water quality conditions. While the macroinvertebrate communities at Stations CG-1 and YC-1 seem to show the seasonal changes associated with spring runoff and the communities at Stations YC-2 and YC-3 do not. Benthic macroinvertebrate samples from all four of these sites are, basically, similar in taxonomic composition; that is they all had relatively low diversity values. This is characteristic of small, turbid streams in the semiarid West, where relatively silty substrates, high total dissolved solids and appreciable fluctuations in flow are commonly found.

## 4.3 SUMMARY

Physical parameters examined at each of the aquatic sampling stations indicate seasonal as well as annual variability. A trend of increased downstream conductivity measurements was identified.

Selected water quality measurements made in 1982 and throughout the MDP program indicate a trend in increasing concentration with distance downstream from Tract C-a. Sodium, bicarbonate, total dissolved solids and alkalinity each were demonstrated, statistically, to be good indicators of water quality differences among the stations sampled.

Year to year variations in seasonal periphyton densities occur and are directly related to such highly variable environmental parameters as current velocity, temperature, light, spring runoff, turbidity and substrate type. The 1982 density estimates at station CG-1 were higher than other MDP values for this station, and changes in species composition indicate a slightly higher organic load. Changes in species dominance over time at this site are probably naturally induced since such changes are not uncommon in aquatic habitats like Corral Gulch.

Station YC-3 on Yellow Creek has spring and fall periphyton communities which appear to be dominated by a group of diatoms whose relative abundance varies annually. There has been an increasing summer trend of green algal density at station YC-3 during the MDP monitoring studies from 1979 through 1982.

The benthic macroinvertebrate fauna at station CG-1 are characteristic of the fluctuating conditions common to small streams in semiarid regions. Station CG-1 is located in an area characterized by variable flow and turbidity. As might be expected under such conditions, minor seasonal changes in benthic macroinvertebrate densities occurred at this station in 1982.

Yellow Creek is a small ephemeral creek also affected by natural fluctuations in hydraulic and water quality parameters. The upper Yellow Creek station, YC-1, showed similarities to station CG-1 in seasonal changes in macroinvertebrate densities. Stations YC-2 and YC-3 on lower Yellow Creek have similar macroinvertebrate communities characterized by organisms tolerant of relatively high conductivities.

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# SECTION 5
# HYDROLOGY STUDIES

## 5.0 INTRODUCTION

During 1981, the hydrology monitoring program was modified to focus on four proposed major development activities or areas on Tract C-a (RBOSC 1981):

1. Dewatering/Reinjection/Discharge
2. MIS Modular Development Area
3. Open Pit
4. Lurgi Plant Site

This discussion of the 1982 monitoring program is divided into two sections corresponding to above-listed items 1 and 2. The open pit and plant site monitoring programs are related to the Lurgi demonstration project, which has been deferred.

Data on surface water, ground water, and development activities (e.g. ponds and surface discharges) monitoring are included in this section. The surface water monitoring program includes data from the U.S. Geological Survey (USGS) gaging stations located on or near Tract C-a, from additional flume-monitor sites, and from measurements taken at the springs and seeps in the area. Ground water data have been collected from alluvial, upper aquifer, and lower aquifer monitor wells.

The development activities monitoring program includes sampling of the quantity and quality of waters associated with dewatering and reinjection operations on Tract C-a.

Brief data summaries and analyses needed to support discussion of the monitoring data are presented in this section. Raw data and selected analyses are provided in Appendix 5.

The hydrology monitoring stations have been classified as follows:

- Type I - control stations not expected to be influenced by a given set of development activities.

- o Type II - stations expected to detect direct, relatively short-term impacts, should impacts result from development; such stations are located generally downgradient from development activities or operations.

- o Type III - stations expected to detect indirect or long-term impacts, should impacts result from development; such stations are generally located downgradient from development areas.

The grouping of monitoring stations allows for spatial as well as temporal comparison of water quality and physical parameters. Thus "pre-" and "post-" development levels and the "control" vs "potentially affected" areas can be compared. The approach to designating station groups involved clustering stations based on knowledge of the hydrogeologic system and of potential impacts from development.

During 1982, the hydrology monitoring program was modified initially to address the post-MIS mine maintenance operations and then to address the lease suspension period initiated in August. Thus the data presented and discussed in this section reflect a transition from MIS-operation to post-operation/suspension operations.

## 5.1 DEWATERING/REINJECTION/DISCHARGE PROGRAM

### 1. Objectives

The objectives of this program are to monitor the operation of the dewatering/reinjection system and to measure the effects on surface and ground water systems.

### 2. Methods

The upper aquifer in the vicinity of the MIS area has been dewatered to allow mining and retorting operations. The existing system is designed to maintain the cone of depression; reinjecting near-mine ground water downgradient from the mine. Alternatively, the dewatering flow can be released to surface stream channels. The major potential effects of this development activity are changes in ground water levels and surface flows (during periods of surface release). In addition to water level and flow data, general water quality parameters (pH, water temperature, and specific conductance (conductivity or ec)) are sampled. Sampling methods are as described in previous MDP monitoring reports (eg. RBOSC, 1981b). Stations included in the dewatering/reinjection/discharge monitoring program are as follows:

| Station Class | Station and Identification | | | |
|---|---|---|---|---|
| | 1981 Program | | Lease Suspension Program | |
| Type I Control | Springs & Seeps | | | |
| | SPG-3 | SPG-8 | SPG-3 | SPG-5 |
| | SPG-4 | SPG-MILL | SPG-4 | SPG-MILL |
| | SPG-5 | | | |
| | Deep Aquifer | | | |
| | GS-M9U | AM-3U | GS-M9U | AM-3U |
| | GS-M10U | GS-9U | GS-M10U | GS-9U |
| | GS-M11U | AM-2U | GS-M12U | |
| | GS-M12U | | CE-708U | |
| | CE-708U | | | |

| Station Class | Station and Identification | |
|---|---|---|
| | 1981 Program | Lease Suspension Program |
| Type II Near-Field | **Active Dewatering Wells** | |
| | GS-D6U GS-D8U | |
| | **Mine Seepage** | |
| | MISUMP (discharge to Jeffrey Pond) | Mine water and sour water systems |
| | **Active Reinjection Wells** | |
| | YCOINJ GS-6U | YCOINJ |
| | TO-2U GS-20U | |
| | GS-4-5U GS-21U | |
| | TO-3U | |
| | **Discharge Sites/Streams** | |
| | YFLDIS | YFLDIS |
| | **Deep Aquifer** | |
| | GS-D5U GS-MDP2CU | GS-D1U GS-D6U |
| | GS-D1U CE-702U | GS-D3U GS-D8U |
| | GS-D4U | GS-MDP2CU CE-702U |
| Type III Far-Field | **Streams** | |
| | E-USGS | YLDGEDGE |
| | YLDGEDGE | |
| | **Deep Aquifer** | |
| | GS-M2U GS-M5U | GS-M3U |
| | GS-M3U GS-11U | CE-702U |
| | GS-10U GS-13U | CE-709U |
| | GS-12U | |
| | GS-19L CE-702L | GS-17L |
| | GS-M4L GS-17L | |

## 3. Results and Discussion

The monitoring data have been examined for temporal and spatial variations. Temporal changes were examined by comparing 1982 univariate statistics (e.g., mean and maximum values) with similar statistics for previous years. The major focus of these evaluations was on comparison of 1981 and 1982 data sets, although longer term changes and trends were also examined.

Extensive repetition of previously reported (pre-1982) data has been avoided. The 1981 data base is provided in RBOSC (1982). Spatial changes were examined by comparison of univariate statistics for upper aquifer wells divided into control, near-field, and far-field station groups. In addition, a multivariate analysis of variance (MANOVA) procedure was used to test the significance of temporal and spatial variability and space-time interactions.

Unless noted otherwise, the parameters discussed and listed in this section and associated appendices have the following units: water chemistry constituents, milligrams per liter; mercury, micrograms per liter; pH, standard units; conductivity (or ec), micromhos per cm; temperature, degrees Celsius.

A. Dewatering/Reinjection System

During 1982, the dewatering operation was accomplished using mine sumps; dewatering wells were not operated. This resulted in only minor modification of the cone of depression. The 1982 cone of depression (Figure 5-1) exhibited a diminishing of the -200 foot contour relative to 1981 (Figure 5-2), while the -100 foot contour was essentially unchanged. The area of the -60 and -20 foot contours also decreased somewhat during 1982.

Dewatering flows were all reinjected or consumed during 1982 except in March and September when a reinjection line break necessitated the rerouting of mine water to the discharge flume. Flows up to 144 gallons per minute were released in March and up to 404 gallons per minute were released in September. Total surface discharge was less than 2 acre-feet in March and less than 3 acre-feet in September.

During 1982, total mine water production varied from zero during pump upsets in the fall, to over 1650 gallons per minute in November when new dewatering pumps were installed. During the first half of the year, mine water flows were in the 1100 to 1200 gallons per minute range. At the end

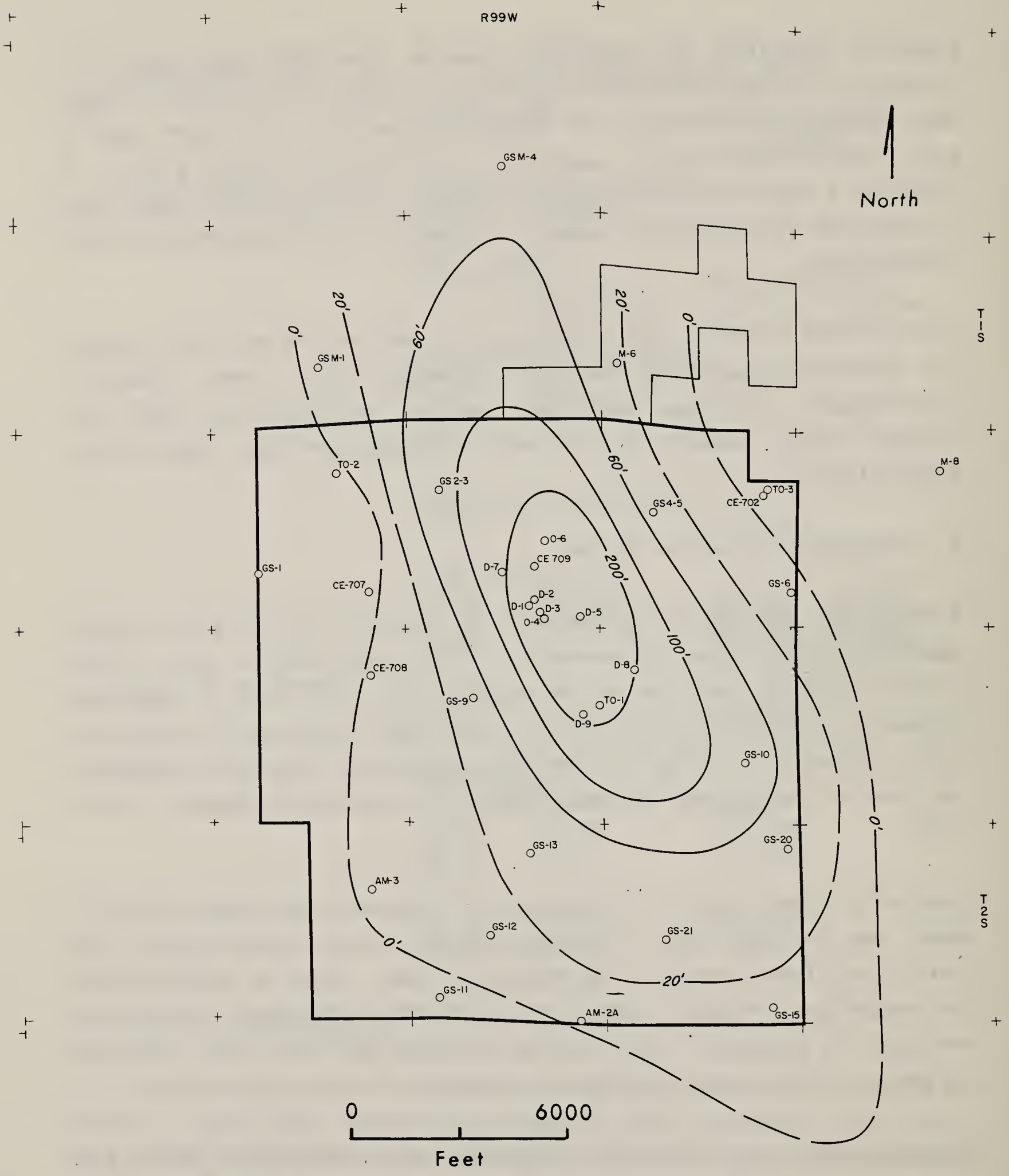


Figure 5-1. Upper Aquifer Cone of Depression October, 1982

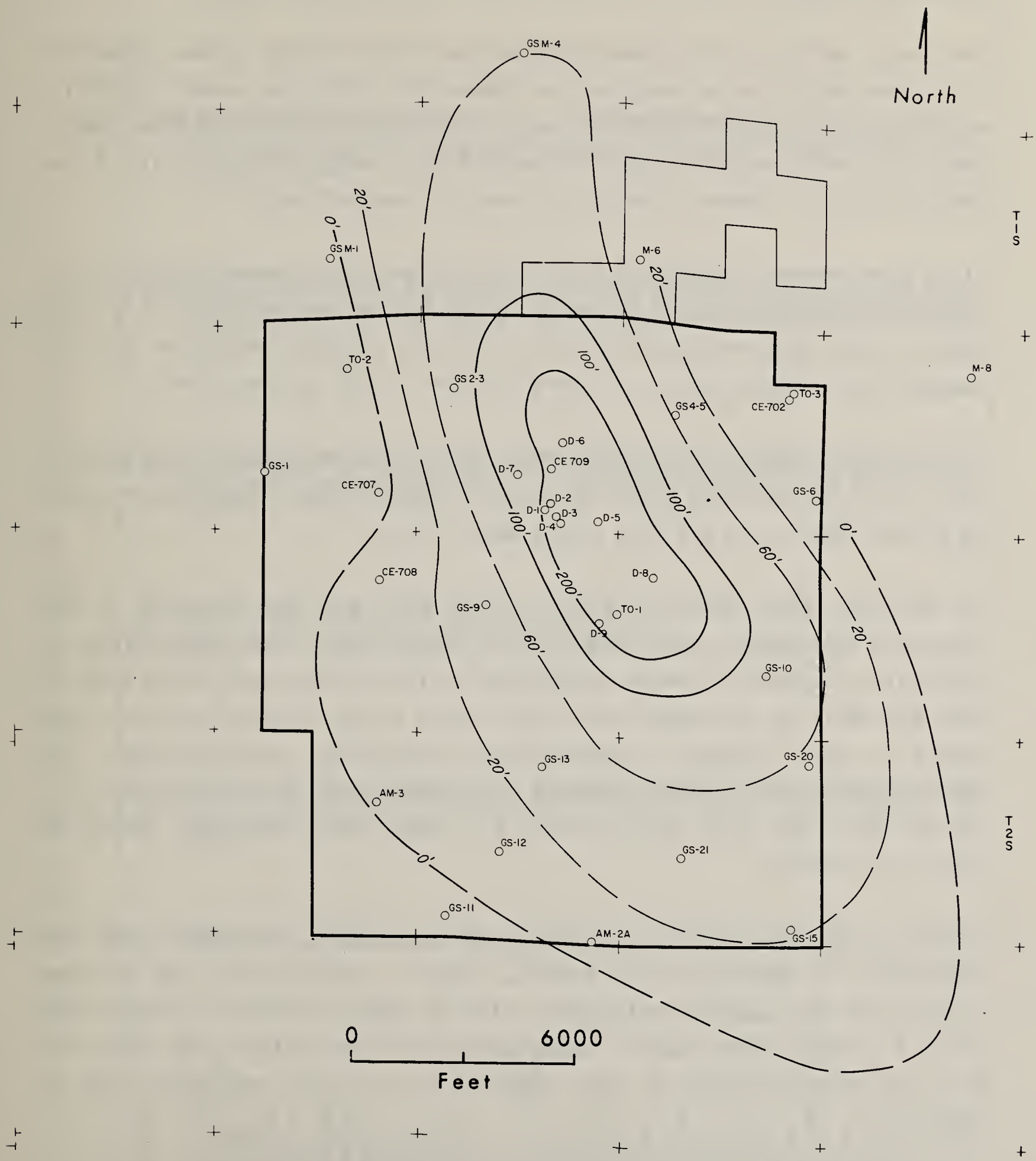


Figure 5-2. Upper Aquifer Cone of Depression October, 1981

of the year, after the upset period, flows were in the 800 to 1000 gallons per minute range.

The water quality of the dewatering/reinjection/discharge system (Appendix 5-1.1) was monitored by sampling the composite reinjection water (YCOINJ); and the Jeffrey Pond (YJEFFPOND), which receives water from the mine sumps. Dewatering wells were not operated during 1982. Water chemistry data from these stations is shown in Tables 5-1 and 5-2, respectively.

Field measurements (Appendix 5-1.2) of the Jeffrey Pond showed conductivity varying from 1300 to 1500 micromhos per cm and pH varying from 7.9 to 9.1. Means of 1982 observations were 8.2 for pH and 1430 micromhos per cm for conductivity. These results are very similar to 1981 observations.

For the 1982 composite reinjection flow, field measured conductivity ranged from 1300 to 1700 with a mean of 1436 micromhos per cm. Reinjection water pH varied from 7.0 to 8.5 with a 1982 mean of 8.1.

As expected, water quality in the Jeffrey Pond and that observed in the composite reinjection water were similar during 1982. The conductivity of composite reinjection water as measured in lab analyses was in the 1300 to 1600 micromhos per cm range during 1982 with a slight minimum in July, due mostly to small changes in magnesium and bicarbonate concentrations. Of the eighteen trace elements sampled in October, only Br (0.96 mg/l), Li (0.09 mg/l), Mn (0.01 mg/l) and Sr (7.5 mg/l) were above the detection limits of analysis.

Overall, the water quality of mine water was stable throughout 1982 and comparable to observation of previous years. Conductivity and pH time series for the composite reinjection flow for 1982 are shown in Figures 5-3 and 5-4. Major water quality constituents for which either 1982 mean or maximum values exceeded the 1981 values in the composite reinjection are as follows:

Table 5-1. Summary of Water Quality Data for Composite Reinjection, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 3 | 8.23 | 0.15 | 8.40 | 8.10 | 8.10 | 8.40 |
| CONDUCTIVITY | 3 | 1466.67 | 152.75 | 1600.00 | 1300.00 | 1300.00 | 1600.00 |
| TOT DIS SOLIDS | 3 | 1024.33 | 17.04 | 1044.00 | 1014.00 | 1014.00 | 1044.00 |
| ALKALINITY | 3 | 483.33 | 10.21 | 495.00 | 476.00 | 476.00 | 495.00 |
| CALCIUM | 3 | 41.67 | 2.89 | 45.00 | 40.00 | 40.00 | 45.00 |
| MAGNESIUM | 3 | 78.67 | 2.31 | 80.00 | 76.00 | 76.00 | 80.00 |
| POTASSIUM | 3 | 0.41 | 0.08 | 0.50 | 0.37 | 0.37 | 0.50 |
| SODIUM | 3 | 203.33 | 5.77 | 210.00 | 200.00 | 200.00 | 210.00 |
| BICARBONATE | 3 | 561.67 | 20.21 | 580.00 | 540.00 | 540.00 | 580.00 |
| CARBONATE | 3 | 0.41 | 0.69 | 1.21 | 0.01 | 0.01 | 1.21 |
| CHLORIDE | 3 | 9.38 | 1.29 | 10.87 | 8.63 | 8.63 | 10.87 |
| NITRATE | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| SULFATE | 3 | 370.40 | 25.02 | 389.20 | 342.00 | 342.00 | 389.20 |
| FLUORIDE | 3 | 1.52 | 0.10 | 1.58 | 1.40 | 1.40 | 1.58 |
| AMMONIA | 3 | 0.18 | 0.04 | 0.20 | 0.13 | 0.13 | 0.20 |
| PHOSPHATE | 3 | 0.02 | 0.01 | 0.03 | 0.01 | 0.01 | 0.03 |
| BORON | 3 | 0.21 | 0.05 | 0.24 | 0.16 | 0.16 | 0.24 |
| SILICA | 3 | 26.00 | 1.00 | 27.00 | 25.00 | 25.00 | 27.00 |
| IRON | 0 | • | • | • | • | • | • |
| DIS ORG CARBON | 3 | 4.60 | 3.67 | 8.80 | 2.00 | 2.00 | 8.80 |
| ARSENIC | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 3 | 0.37 | 0.23 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 3 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 1 | 0.10 | • | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 1 | 0.10 | • | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 1 | 0.96 | • | 0.96 | 0.96 | 0.96 | 0.96 |
| CADMIUM | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 1 | 0.50 | • | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 1 | 0.10 | • | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 1 | 0.09 | • | 0.09 | 0.09 | 0.09 | 0.09 |
| MANGANESE | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| NICKEL | 1 | 0.05 | • | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 1 | 7.50 | • | 7.50 | 7.50 | 7.50 | 7.50 |
| TITANIUM | 1 | 0.50 | • | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 1 | 0.01 | • | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 1 | 10.00 | • | 10.00 | 10.00 | 10.00 | 10.00 |

Table 5-2. Summary of Water Quality Data for Jeffrey Pond, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 6 | 8.20 | 0.20 | 8.30 | 7.80 | 7.80 | 8.30 |
| CONDUCTIVITY | 6 | 1416.67 | 20.41 | 1450.00 | 1400.00 | 1400.00 | 1450.00 |
| TOT DIS SOLIDS | 6 | 974.50 | 94.64 | 1060.00 | 792.00 | 792.00 | 1060.00 |
| ALKALINITY | 6 | 458.17 | 46.16 | 497.00 | 367.00 | 367.00 | 497.00 |
| CALCIUM | 6 | 40.33 | 3.44 | 46.00 | 36.00 | 36.00 | 46.00 |
| MAGNESIUM | 6 | 79.00 | 2.90 | 83.00 | 75.00 | 75.00 | 83.00 |
| POTASSIUM | 6 | 0.49 | 0.11 | 0.69 | 0.36 | 0.36 | 0.69 |
| SODIUM | 6 | 195.17 | 22.63 | 210.00 | 150.00 | 150.00 | 210.00 |
| BICARBONATE | 6 | 529.17 | 63.96 | 583.00 | 404.00 | 404.00 | 583.00 |
| CARBONATE | 6 | 0.81 | 1.46 | 3.62 | 0.01 | 0.01 | 3.62 |
| CHLORIDE | 6 | 8.37 | 1.54 | 9.52 | 5.38 | 5.38 | 9.52 |
| NITRATE | 6 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| SULFATE | 6 | 349.50 | 53.73 | 428.00 | 285.00 | 285.00 | 428.00 |
| FLUORIDE | 6 | 1.48 | 0.10 | 1.60 | 1.33 | 1.33 | 1.60 |
| AMMONIA | 6 | 0.20 | 0.10 | 0.33 | 0.05 | 0.05 | 0.33 |
| PHOSPHATE | 6 | 0.04 | 0.05 | 0.11 | 0.01 | 0.01 | 0.11 |
| BORON | 6 | 0.21 | 0.08 | 0.29 | 0.06 | 0.06 | 0.29 |
| SILICA | 6 | 25.67 | 2.80 | 27.00 | 20.00 | 20.00 | 27.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 6 | 4.83 | 1.60 | 7.00 | 3.00 | 3.00 | 7.00 |
| ARSENIC | 6 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 |
| SELENIUM | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 6 | 0.43 | 0.16 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 6 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 6 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 1 | 0.40 | . | 0.40 | 0.40 | 0.40 | 0.40 |
| CADMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 1 | 0.11 | . | 0.11 | 0.11 | 0.11 | 0.11 |
| MANGANESE | 1 | 0.05 | . | 0.05 | 0.05 | 0.05 | 0.05 |
| NICKEL | 1 | 0.05 | . | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 1 | 7.00 | . | 7.00 | 7.00 | 7.00 | 7.00 |
| TITANIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 1 | 0.11 | . | 0.11 | 0.11 | 0.11 | 0.11 |
| ZIRCONIUM | 1 | 10.00 | . | 10.00 | 10.00 | 10.00 | 10.00 |

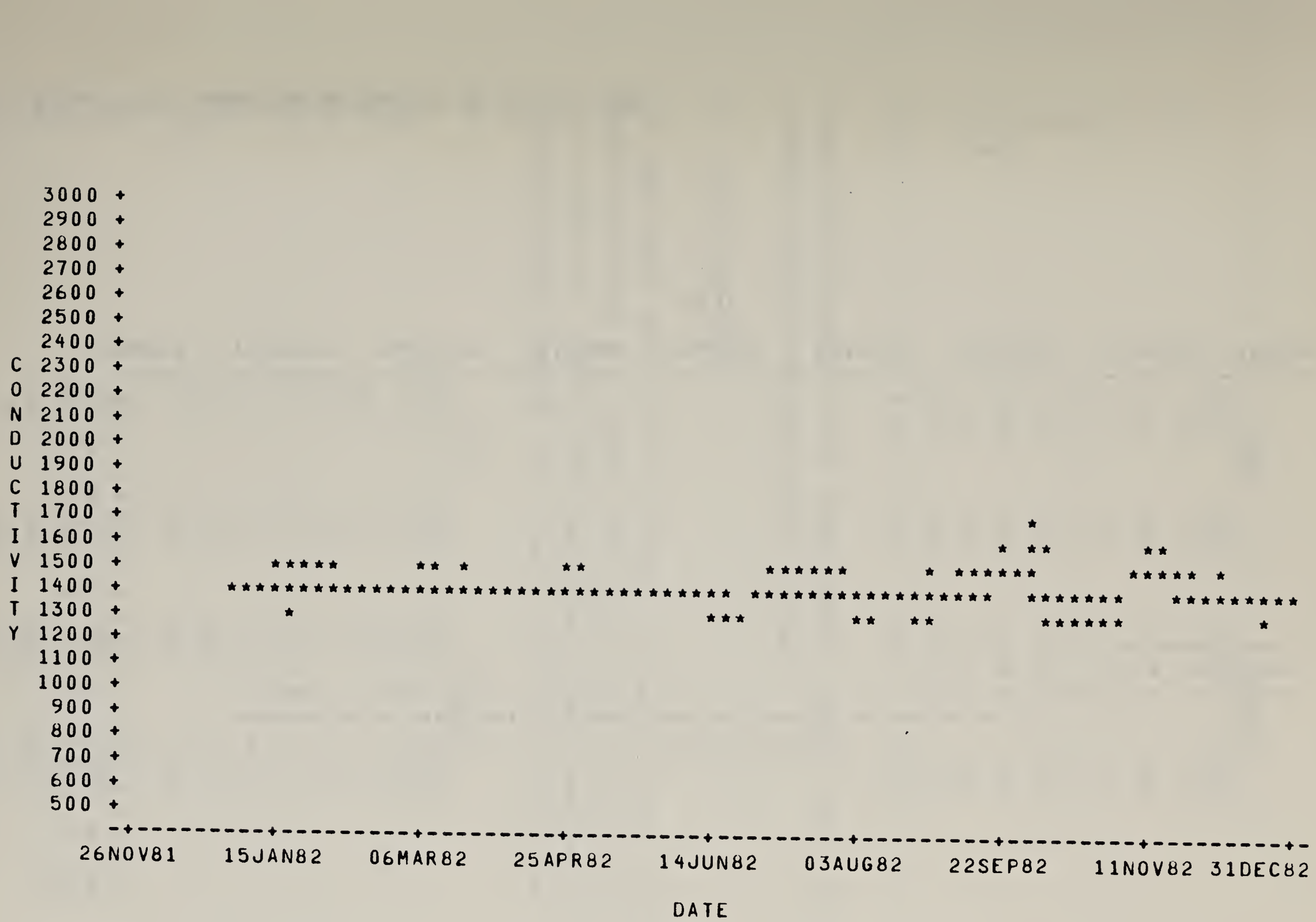


Figure 5-3. Conductivity (micromhos per cm) of Composite Reinjection, YCOINJ, 1982

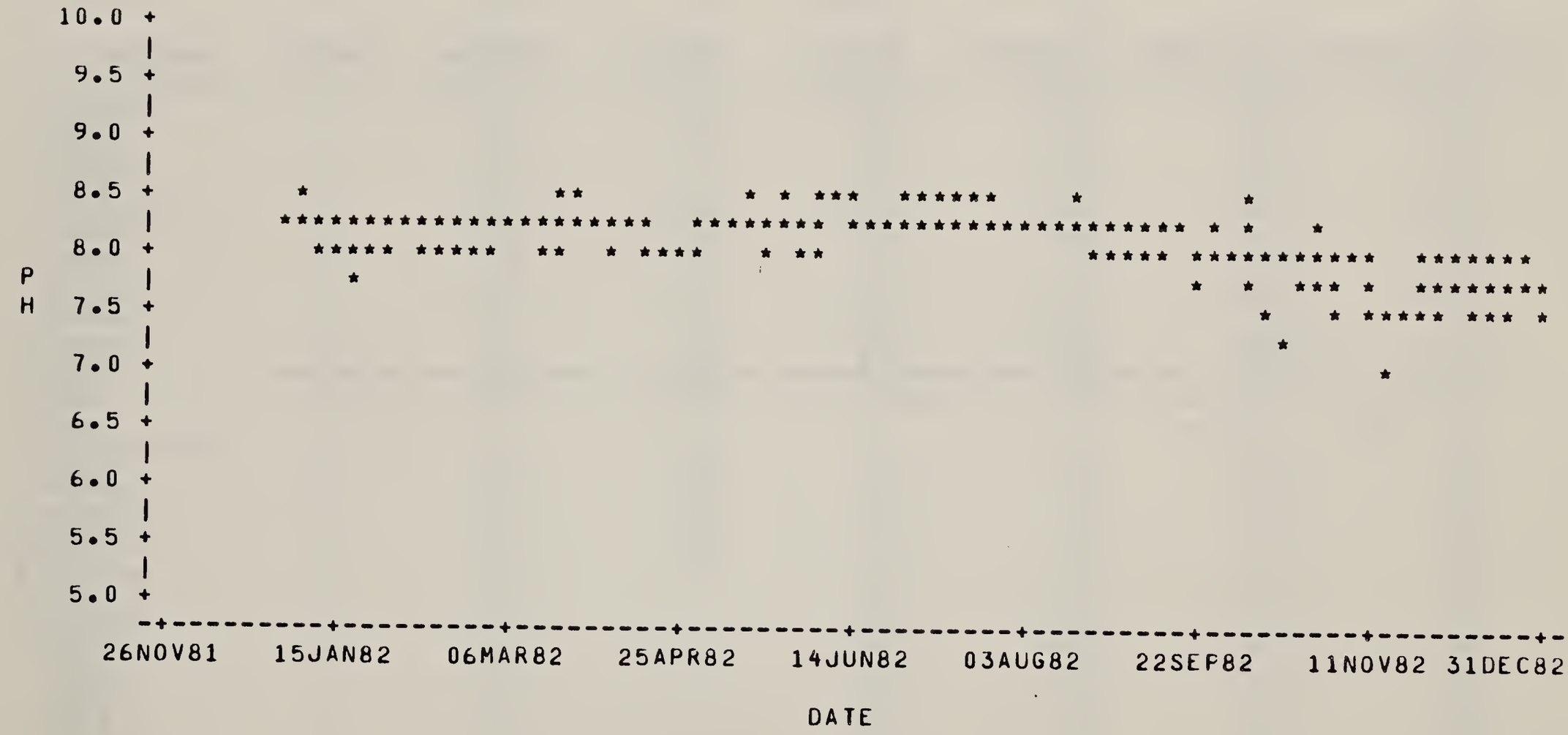


Figure 5-4. Composite Reinjection pH (S.U.), 1982

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 8.2 | 7.7 | 8.4 | 7.7 |
| ec | 1467 | 1417 | 1600 | 1500 |
| Ca | 42 | 41 | 45 | 44 |
| Mg | 79 | 77 | 80 | 78 |
| Na | 203 | 197 | 210 | 210 |
| $HCO_3$ | 562 | 567 | 580 | 578 |
| $SO_4$ | 370 | 377 | 389 | 388 |
| F | 1.52 | .48 | 1.58 | .62 |
| DOC | 4.6 | 5.7 | 8.8 | 8.0 |

These data show generally small changes between 1982 and 1981. Similarly, changes in Jeffrey Pond water quality were small.

B. Springs and Seeps

The 1982 water quality data collected at control spring stations are summarized in Table 5-3. Springs and seeps data are presented in Appendix 5-1.1 and 5-1.2. Although 1982 observations for most constituents were not greatly different from 1981 data, several insignificant changes were noted:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.6 | 7.9 | 8.5 | 8.9 |
| ec | 1383 | 1152 | 1850 | 1775 |
| Ca | 98 | 110 | 120 | 140 |
| Mg | 66 | 67 | 83 | 88 |
| K | 1.4 | 1.6 | 4.4 | 2.2 |
| Na | 129 | 118 | 240 | 230 |
| $HCO_3$ | 549 | 521 | 829 | 821 |
| Cl | 13 | 18 | 23 | 44 |
| $SO_4$ | 327 | 345 | 435 | 420 |
| F | .33 | .30 | .62 | .37 |
| $NH_3$ | .20 | .84 | .88 | 1.40 |
| B | .24 | .29 | .61 | .45 |
| DOC | 6.1 | 7.2 | 11.0 | 16.0 |

Table 5-3. Summary of Water Quality Data for Springs and Seeps, Dewatering/Reinjection/ Discharge Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 13 | 7.63 | 0.45 | 8.50 | 6.80 | 6.80 | 8.50 |
| CONDUCTIVITY | 13 | 1382.69 | 254.01 | 1850.00 | 1100.00 | 1100.00 | 1850.00 |
| TOT DIS SOLIDS | 13 | 932.23 | 237.10 | 1340.00 | 612.00 | 612.00 | 1340.00 |
| ALKALINITY | 13 | 473.46 | 121.47 | 710.00 | 383.00 | 383.00 | 710.00 |
| CALCIUM | 13 | 97.62 | 10.54 | 120.00 | 80.00 | 80.00 | 120.00 |
| MAGNESIUM | 13 | 66.08 | 12.55 | 83.00 | 52.00 | 52.00 | 83.00 |
| POTASSIUM | 13 | 1.35 | 0.95 | 4.40 | 0.84 | 0.84 | 4.40 |
| SODIUM | 13 | 128.62 | 64.58 | 240.00 | 74.00 | 74.00 | 240.00 |
| BICARBONATE | 13 | 549.00 | 149.10 | 829.00 | 417.00 | 417.00 | 829.00 |
| CARBONATE | 13 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 13 | 12.83 | 5.12 | 22.80 | 7.28 | 7.28 | 22.80 |
| NITRATE | 13 | 0.51 | 0.37 | 1.10 | 0.10 | 0.10 | 1.10 |
| SULFATE | 13 | 327.46 | 80.11 | 435.00 | 216.00 | 216.00 | 435.00 |
| FLUORIDE | 13 | 0.33 | 0.13 | 0.62 | 0.19 | 0.19 | 0.62 |
| AMMONIA | 13 | 0.20 | 0.25 | 0.88 | 0.05 | 0.05 | 0.88 |
| PHOSPHATE | 13 | 0.06 | 0.04 | 0.13 | 0.01 | 0.01 | 0.13 |
| BORON | 13 | 0.24 | 0.17 | 0.61 | 0.04 | 0.04 | 0.61 |
| SILICA | 13 | 21.85 | 3.72 | 29.00 | 14.00 | 14.00 | 29.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 13 | 6.08 | 3.17 | 11.00 | 2.00 | 2.00 | 11.00 |
| ARSENIC | 13 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 13 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 13 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 13 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 13 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |

C. Upper Aquifer

1. Field Data - Summaries of 1982 field data for control, near-field and far-field station groups are presented in Table 5-4. Data collected in 1982 are provided in Appendix 5-1.3. Mean water levels (depth to water) in all three areas for 1982 were less than that for 1981, which is a reflection of the changes in the shape of the cone of depression. However, minimum and maximum water levels did not change appreciably from 1981 to 1982.

The mean conductivity in upper aquifer control wells during 1982 was less than that observed in 1981 but minimum and maximum values for the two years were comparable. Ground-water pH showed no appreciable change between 1981 and 1982. The 1982 mean conductivity in near-field and far-field wells were comparable to 1981 mean values (1981 data are presented in RBOSC, 1982). However maximum observed conductivity was higher in 1982 (vs. 1981) in both well groupings. Near-field 1982 maximum conductivity was 1900 (at GS-MDP2CU in March) as compared to the 1981 maximum of 1625 micromhos per cm. Conductivity at GS-MDP2CU ranged from 1300 to 1900 micromhos per cm during 1982. The far-field 1982 maximum conductivity was 3250 (at GS-M5U in July) while the 1981 maximum observation was 2050 micromhos per cm. Well GS-M5U typically exhibits conductivity greater than other upper aquifer wells.

The 1982 summaries shown in Table 5-4 illustrate spatial gradients in the upper aquifer. As expected, mean depth to water is greater in the near-field due to dewatering operations. As observed in previous years (RBOSC 1982), ground-water temperature is generally greater in the near-field relative to surrounding areas. Conductivity generally increases from control to near-field to far-field stations. Although pH increases from control to near-field and far-field areas, the changes are not great.

Table 5-4. Summary of Field Data from Upper Aquifer Wells, Dewatering/Reinjection/Discharge Program, 1982.

TYPE=UPPER AQUIFER AREA=CONTROL REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 72 | 142.27 | 157.69 | 439.30 | 25.50 | 25.76 | 436.63 |
| TEMPERATURE | 10 | 11.48 | 2.03 | 14.50 | 8.50 | 8.50 | 14.50 |
| CONDUCTIVITY | 10 | 1355.00 | 596.03 | 3000.00 | 950.00 | 950.00 | 3000.00 |
| PH | 10 | 7.71 | 0.38 | 8.40 | 7.00 | 7.00 | 8.40 |

TYPE=UPPER AQUIFER AREA=NEAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 323 | 399.63 | 157.99 | 630.20 | 204.00 | 209.00 | 589.56 |
| TEMPERATURE | 11 | 15.16 | 0.85 | 16.30 | 13.50 | 13.50 | 16.30 |
| CONDUCTIVITY | 11 | 1459.09 | 251.81 | 1900.00 | 1100.00 | 1100.00 | 1900.00 |
| PH | 11 | 8.08 | 0.28 | 8.60 | 7.70 | 7.70 | 8.60 |

TYPE=UPPER AQUIFER AREA=FAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 249 | 204.67 | 176.39 | 550.70 | 11.40 | 12.10 | 539.90 |
| TEMPERATURE | 20 | 11.81 | 1.83 | 14.20 | 7.80 | 7.81 | 14.19 |
| CONDUCTIVITY | 20 | 1651.25 | 548.77 | 3250.00 | 1150.00 | 1152.50 | 3237.50 |
| PH | 20 | 8.07 | 0.91 | 9.70 | 6.80 | 6.81 | 9.69 |

2. Water Quality Data - Results of water quality analyses of samples collected as part of the 1982 dewatering/reinjection/discharge monitoring program are summarized in Tables 5-5, 5-6, and 5-7. Upper aquifer water chemistry data are presented in Appendix 5-1.1. Water quality observations in upper aquifer control wells during 1982 were generally similar to 1981 values:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.6 | 7.6 | 8.4 | 8.3 |
| ec | 1443 | 1344 | 3000 | 3000 |
| Ca | 99 | 85 | 290 | 266 |
| Mg | 80 | 77 | 180 | 203 |
| K | .84 | .73 | 1.94 | 1.86 |
| Na | 154 | 153 | 250 | 260 |
| $HCO_3$ | 544 | 523 | 884 | 910 |
| Cl | 10.6 | 9.1 | 12.9 | 11.3 |
| $SO_4$ | 452 | 433 | 1271 | 1364 |
| F | .49 | .31 | .97 | .94 |
| $NH_3$ | .50 | .62 | 2.2 | 1.80 |
| B | .20 | .29 | .24 | 1.17 |
| DOC | 6.29 | 5.8 | 9.0 | 10.0 |

These data show increases and decreases in mean and maximum observations for some constituents between 1981 and 1982 (e.g. conductivity, calcium, bicarbonate, sulfate). However, these changes are not great.

Water quality observed at upper aquifer near-field wells in 1982 showed somewhat elevated conductivity relative to 1981. However, the concentrations of major ions in near-field wells in 1982 were not appreciably greater than observed in 1981:

Table 5-5. Summary of Water Quality Data for Upper Aquifer Control Wells, Dewatering/ Reinjection/Discharge Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 7 | 7.64 | 0.44 | 8.40 | 7.00 | 7.00 | 8.40 |
| CONDUCTIVITY | 7 | 1442.86 | 701.44 | 3000.00 | 1000.00 | 1000.00 | 3000.00 |
| TOT DIS SOLIDS | 7 | 1144.86 | 691.30 | 2700.00 | 756.00 | 756.00 | 2700.00 |
| ALKALINITY | 7 | 465.86 | 133.82 | 759.00 | 381.00 | 381.00 | 759.00 |
| CALCIUM | 7 | 98.57 | 86.88 | 290.00 | 33.00 | 33.00 | 290.00 |
| MAGNESIUM | 7 | 79.86 | 45.76 | 180.00 | 41.00 | 41.00 | 180.00 |
| POTASSIUM | 7 | 0.84 | 0.57 | 1.94 | 0.38 | 0.38 | 1.94 |
| SODIUM | 7 | 154.14 | 51.39 | 250.00 | 101.00 | 101.00 | 250.00 |
| BICARBONATE | 7 | 544.00 | 155.88 | 884.00 | 443.00 | 443.00 | 884.00 |
| CARBONATE | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 7 | 10.60 | 2.21 | 12.90 | 6.16 | 6.16 | 12.90 |
| NITRATE | 7 | 0.53 | 0.96 | 2.70 | 0.10 | 0.10 | 2.70 |
| SULFATE | 7 | 451.86 | 365.90 | 1271.00 | 199.00 | 199.00 | 1271.00 |
| FLUORIDE | 7 | 0.49 | 0.33 | 0.97 | 0.10 | 0.10 | 0.97 |
| AMMONIA | 7 | 0.50 | 0.76 | 2.20 | 0.05 | 0.05 | 2.20 |
| PHOSPHATE | 7 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 |
| BORON | 7 | 0.20 | 0.03 | 0.24 | 0.16 | 0.16 | 0.24 |
| SILICA | 7 | 30.14 | 12.60 | 53.00 | 15.00 | 15.00 | 53.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 7 | 6.29 | 2.14 | 9.00 | 3.00 | 3.00 | 9.00 |
| ARSENIC | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 7 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 7 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 7 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 7 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 7 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 7 | 0.41 | 0.34 | 1.00 | 0.10 | 0.10 | 1.00 |
| CADMIUM | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 7 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 7 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 7 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 7 | 0.05 | 0.02 | 0.09 | 0.02 | 0.02 | 0.09 |
| MANGANESE | 7 | 0.08 | 0.13 | 0.36 | 0.01 | 0.01 | 0.36 |
| NICKEL | 7 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 7 | 3.20 | 1.09 | 4.17 | 1.38 | 1.38 | 4.17 |
| TITANIUM | 7 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 7 | 0.05 | 0.05 | 0.14 | 0.01 | 0.01 | 0.14 |
| ZIRCONIUM | 7 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

Table 5-6. Summary of Water Quality Data for Upper Aquifer Near-Field Wells, Dewatering/ Reinjection/Discharge Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 6 | 7.90 | 0.18 | 8.20 | 7.70 | 7.70 | 8.20 |
| CONDUCTIVITY | 6 | 1466.67 | 258.20 | 1800.00 | 1100.00 | 1100.00 | 1800.00 |
| TOT DIS SOLIDS | 7 | 1053.00 | 152.81 | 1275.00 | 890.00 | 890.00 | 1275.00 |
| ALKALINITY | 7 | 447.14 | 39.58 | 498.00 | 399.00 | 399.00 | 498.00 |
| CALCIUM | 7 | 48.43 | 19.70 | 76.00 | 26.00 | 26.00 | 76.00 |
| MAGNESIUM | 7 | 91.29 | 13.03 | 110.00 | 80.00 | 80.00 | 110.00 |
| POTASSIUM | 7 | 0.41 | 0.11 | 0.55 | 0.26 | 0.26 | 0.55 |
| SODIUM | 7 | 178.57 | 21.93 | 200.00 | 150.00 | 150.00 | 200.00 |
| BICARBONATE | 7 | 516.14 | 60.24 | 595.00 | 449.00 | 449.00 | 595.00 |
| CARBONATE | 7 | 0.44 | 0.76 | 1.82 | 0.01 | 0.01 | 1.82 |
| CHLORIDE | 7 | 9.24 | 2.02 | 11.10 | 5.70 | 5.70 | 11.10 |
| NITRATE | 7 | 0.19 | 0.23 | 0.70 | 0.10 | 0.10 | 0.70 |
| SULFATE | 7 | 435.29 | 127.37 | 635.00 | 321.00 | 321.00 | 635.00 |
| FLUORIDE | 7 | 1.37 | 0.48 | 1.97 | 0.76 | 0.76 | 1.97 |
| AMMONIA | 7 | 0.23 | 0.10 | 0.34 | 0.05 | 0.05 | 0.34 |
| PHOSPHATE | 7 | 0.05 | 0.06 | 0.16 | 0.01 | 0.01 | 0.16 |
| BORON | 7 | 0.27 | 0.05 | 0.33 | 0.21 | 0.21 | 0.33 |
| SILICA | 7 | 26.29 | 3.50 | 32.00 | 22.00 | 22.00 | 32.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 7 | 7.43 | 5.65 | 17.00 | 2.00 | 2.00 | 17.00 |
| ARSENIC | 7 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 |
| SELENIUM | 7 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 7 | 0.39 | 0.20 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 7 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 7 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 2 | 0.20 | 0.14 | 0.30 | 0.10 | 0.10 | 0.30 |
| CADMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 2 | 0.11 | 0.02 | 0.13 | 0.10 | 0.10 | 0.13 |
| MANGANESE | 2 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| NICKEL | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 2 | 4.79 | 1.85 | 6.10 | 3.48 | 3.48 | 6.10 |
| TITANIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 2 | 0.08 | 0.10 | 0.15 | 0.01 | 0.01 | 0.15 |
| ZIRCONIUM | 2 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

Table 5-7. Summary of Water Quality Data for Upper Aquifer Far-Field Wells, Dewatering/ Reinjection/Discharge Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 11 | 7.66 | 0.63 | 9.00 | 6.80 | 6.80 | 9.00 |
| CONDUCTIVITY | 11 | 1622.73 | 558.40 | 3250.00 | 1275.00 | 1275.00 | 3250.00 |
| TOT DIS SOLIDS | 12 | 1156.58 | 197.71 | 1608.00 | 940.00 | 940.00 | 1608.00 |
| ALKALINITY | 12 | 512.83 | 57.49 | 638.00 | 443.00 | 443.00 | 638.00 |
| CALCIUM | 12 | 66.96 | 47.57 | 130.00 | 3.70 | 3.70 | 130.00 |
| MAGNESIUM | 12 | 85.42 | 21.25 | 120.00 | 46.00 | 46.00 | 120.00 |
| POTASSIUM | 12 | 0.80 | 0.65 | 2.30 | 0.34 | 0.34 | 2.30 |
| SODIUM | 12 | 197.50 | 40.48 | 290.00 | 140.00 | 140.00 | 290.00 |
| BICARBONATE | 12 | 555.83 | 123.87 | 757.00 | 312.00 | 312.00 | 757.00 |
| CARBONATE | 12 | 2.37 | 5.77 | 18.10 | 0.01 | 0.01 | 18.10 |
| CHLORIDE | 12 | 12.12 | 3.18 | 17.40 | 8.40 | 8.40 | 17.40 |
| NITRATE | 12 | 0.20 | 0.32 | 1.20 | 0.10 | 0.10 | 1.20 |
| SULFATE | 12 | 467.50 | 103.91 | 653.00 | 342.00 | 342.00 | 653.00 |
| FLUORIDE | 12 | 0.86 | 0.65 | 1.70 | 0.10 | 0.10 | 1.70 |
| AMMONIA | 12 | 0.68 | 1.05 | 3.86 | 0.07 | 0.07 | 3.86 |
| PHOSPHATE | 12 | 0.09 | 0.13 | 0.42 | 0.01 | 0.01 | 0.42 |
| BORON | 12 | 0.26 | 0.05 | 0.35 | 0.19 | 0.19 | 0.35 |
| SILICA | 12 | 25.25 | 13.94 | 47.00 | 2.00 | 2.00 | 47.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 12 | 6.17 | 4.11 | 13.00 | 2.00 | 2.00 | 13.00 |
| ARSENIC | 12 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 12 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 12 | 0.43 | 0.16 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 12 | 0.12 | 0.04 | 0.20 | 0.10 | 0.10 | 0.20 |
| MERCURY | 12 | 0.32 | 0.06 | 0.50 | 0.30 | 0.30 | 0.50 |
| ALUMINUM | 4 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 4 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 4 | 0.22 | 0.19 | 0.50 | 0.10 | 0.10 | 0.50 |
| CADMIUM | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 4 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 4 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 4 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 4 | 0.10 | 0.03 | 0.14 | 0.08 | 0.08 | 0.14 |
| MANGANESE | 4 | 0.06 | 0.10 | 0.20 | 0.01 | 0.01 | 0.20 |
| NICKEL | 4 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 4 | 1.48 | 0.97 | 2.17 | 0.10 | 0.10 | 2.17 |
| TITANIUM | 4 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 4 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 |
| ZIRCONIUM | 4 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.9 | 8.5 | 8.2 | 8.7 |
| ec | 1467 | 1450 | 1800 | 1600 |
| Ca | 48 | 51 | 76 | 67 |
| Mg | 91 | 91 | 110 | 96 |
| K | .41 | .34 | .55 | .42 |
| Na | 179 | 170 | 200 | 190 |
| $HCO_3$ | 516 | 485 | 595 | 500 |
| Cl | 9.2 | 9.0 | 11.1 | 9.6 |
| $SO_4$ | 435 | 455 | 635 | 559 |
| F | 1.37 | 1.77 | 1.97 | 2.48 |
| $NH_3$ | .23 | --- | .34 | --- |
| B | .27 | .29 | .33 | .31 |
| DOC | 7.4 | 9.5 | 17.0 | 10.0 |

Mean concentrations of calcium, bicarbonate and fluoride at far-field upper aquifer wells in 1982 were slightly greater than 1981 means. However, the overall water quality at the far-field wells was comparable between the two years:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.7 | 8.3 | 9.0 | 9.8 |
| ec | 1623 | 1556 | 3250 | 2100 |
| Ca | 67 | 60 | 130 | 140 |
| Mg | 85 | 87 | 120 | 120 |
| K | .80 | 1.47 | 2.3 | 6.80 |
| Na | 198 | 220 | 290 | 270 |
| $HCO_3$ | 556 | 525 | 757 | 775 |
| Cl | 12.1 | 12.5 | 17.4 | 25.2 |
| $SO_4$ | 468 | 519 | 653 | 841 |
| F | .86 | .34 | 1.70 | 1.66 |
| $NH_3$ | .68 | .69 | 3.86 | 2.78 |
| B | .26 | .27 | .35 | 1.61 |
| DOC | 6.2 | 8.0 | 13.0 | 37.0 |

As in previous annual analyses, comparison of 1982 water quality data means for control, near-field and far-field upper aquifer wells yielded few consistent patterns. For conductivity, sodium, bicarbonate and sulfate ions, the highest mean was observed at far-field wells. For several of the major constituents, the highest mean was observed at the near-field wells:

| Parameter | 1982 Control Mean | 1982 Near-Field Mean | 1982 Far-Field Mean |
|---|---|---|---|
| Magnesium | 80 | 91 | 85 |
| Fluoride | 0.49 | 1.37 | 0.86 |
| DOC | 6.3 | 7.4 | 6.2 |
| Boron | .20 | .27 | .26 |

For calcium, potassium, bicarbonate, chloride, sulfate and ammonia, the lowest mean was observed at near-field stations.

Most of the trace elements monitored in the upper aquifer were below detection limits during 1982. Typically, of the eighteen trace metals sampled, only Br, Li, Mn, and Sr were measureable (Appendix 5-1.1).

3. Statistical Analysis - The MANOVA for selected upper aquifer water quality parameters indicated significant variability for most constituents (at the .05 significance level) for all parameters except pH, fluoride, chloride, and marginally for bicarbonate for the area main effect. Significant variability for the year main effect was noted only for pH, magnesium, sodium, and chloride:

| Parameter | Probability > F | | |
|---|---|---|---|
| | Area | Year | Area*Year |
| TDS | 0.0001 | 0.6017 | 0.4723 |
| Conductivity | 0.0001 | 0.4937 | 0.4301 |
| pH | 0.0883 | 0.0001 | 0.1095 |
| Alkalinity | 0.0061 | 0.3273 | 0.8199 |
| Calcium | 0.0001 | 0.2132 | 0.8507 |
| Magnesium | 0.0001 | 0.0006 | 0.3331 |
| Sodium | 0.0007 | 0.0007 | 0.9230 |
| Fluoride | 0.1239 | 0.0119 | 0.8465 |
| Chloride | 0.1063 | 0.0225 | 0.7901 |
| Bicarbonate | 0.0474 | 0.0825 | 0.4739 |
| Sulfate | 0.0001 | 0.1005 | 0.4587 |

The interaction term (area x year) was nonsignificant for all of the constituents examined. This indicates a lack of change in the relative water quality at control, near-field, and far-field wells over time, although the variability among station types and years is highly significant for some constituents when just these main effects are considered. This analysis result (including these specific constituents) was also observed for the 1981 analysis.

The evaluation of overall year and area (station type) effects was accomplished using the Hotelling-Lawley trace, Piffai's trace, Wilks' Criterion, and Roy's Maximum Root Criterion (Appendix 5-1.4). These analyses indicated highly significant differences for both the area and year main effects.

The Duncan's Multiple Range Test was used to examine the nature and significance of differences in mean concentrations over time (year) and space (control, near-field, and far-field). Examination of spatial differences indicated the following:

| Parameter | Area significantly different from near-field |
|---|---|
| TDS | Control, Far-field |
| Conductivity | Far-field |
| Alkalinity | Far-field |
| Calcium | Control, Far-field |
| Magnesium | Control, Far-field |
| Sodium | Neither |
| Bicarbonate | Neither |
| Sulfate | Control, Far-field |

For all of these constituents, except calcium, the highest mean was observed for the far-field area. The highest mean for calcium was in the control area. Constituents with nonsignificant variability for the area (station type) main effect were not considered in this Duncan's evaluation.

The Duncan's Multiple Range Test evaluation of differences among years gave the following results (only those constituents with significant variability for the year main effect in the MANOVA were considered):

| Parameter | Years Significantly Different Than 1982 |
|---|---|
| pH | 1975, 1976 |
| Sodium | None |
| Fluoride | None |
| Chloride | 1978 |
| Magnesium | None |

The means estimated for these parameters for the upper aquifer are as follows:

| Parameter | Mean | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1975 | 1976 | 1978 | 1979 | 1980 | 1981 | 1982 |
| pH | 6.8 | 6.9 | 7.4 | 8.0 | 7.9 | 8.0 | 7.7 |
| Magnesium | 65 | 63 | 88 | 79 | 92 | 82 | 85 |
| Sodium | 299 | 325 | 222 | 205 | 200 | 194 | 179 |
| Chloride | 17 | 18 | 7 | 13 | 14 | 11 | 11 |
| Fluoride | 3.1 | 3.0 | 1.7 | 0.8 | 0.6 | 0.4 | 0.9 |

These means show a general increase in pH in the upper aquifer since the baseline and decrease in sodium, chloride and fluoride concentrations since then. Recent years data have been fairly stable for these constituents. The changes in mean concentrations over time for magnesium and chloride are not appreciable.

The MANOVA analyses, and the Duncan's Multiple Range Test results indicate that, although certain constituents vary significantly in time and space, the general pattern of water quality has not changed appreciably over time. Impact-related changes were not apparent from these analyses.

D. Lower Aquifer

The 1982 water level (depth to water) measurements in the far-field lower aquifer wells ranged from 136.6 to 372.2 feet (Appendix 5-1.3). The 1981 range from was 138.0 to 374.1 feet, indicating little change occurred between the two years. To date, there has been no evidence of development-induced effects on the lower aquifer from dewatering/reinjection activities.

## 5.2 MIS Modular Development Area

### 1. Objectives

The monitoring of the MIS Modular Development Area is designed to detect and evaluate the effects of the MIS retorts on deep aquifers, and the effects of surface operations and facilities on surface streams and alluvial aquifers. Monitoring sites include surface streams, alluvial and deep-aquifer wells.

### 2. Methods

Sampling methods are as described in previous reports (eg. RBOSC 1981). Stations included in the MIS Modular Development Area monitoring program are as follows:

| Station Class | Station and Identification | | | |
|---|---|---|---|---|
| | 1981 Program | | Lease Suspension Program | |
| Type I Control | **Streams** | | | |
| | B-USGS | C-USGS | B-USGS | C-USGS |
| | **Springs and Seeps** | | | |
| | SPG-3 | SPG-8 | SPG-3 | SPG-14 |
| | SPG-4 | SPG-14 | SPG-4 | SPG-MILL |
| | SPG-5 | SPG-MILL | SPG-5 | |
| | **Alluvial Aquifer** | | | |
| | GS-S7 | GS-S8 | GS-S7 | GS-S8 |
| | **Deep Aquifer** | | | |
| | GS-10U | GS-15L | GS-15U | GS-15L |
| | GS-15U | CE-708U | CE-708U | GS-9U |
| | GS-9U | | | |
| | **Erosion & Sedimentation** | | | |
| | YES-1A | YES-3 | | |
| Type II Near-Field | **Streams** | | | |
| | D-USGS | YMET3 | D-USGS | YMET3 |
| | YCULDIS | YBOXFL | YCOFL | YBOXFL |
| | YSEOFL | | YSEOFL | |

| Station Class | Station and Identification | | |
|---|---|---|---|
| | 1981 Program | | Lease Suspension Program |
| Type II Near-Field (continued) | Impoundments and Leak Detection System | | |
| | YER Pond | YWRO Pond | |
| | YWR Pond | YJEF Pond | |
| | YERO Pond | YSW 1-7 | |
| | YLEACH-1 | YPZR 1-4 | |
| | Alluvial Aquifer | | |
| | GS-S25 | GS-S27S | GS-S27S |
| | GS-S26 | GS-S27A | GS-S27A |
| | Deep Aquifer | | |
| | CE-709U | CE-702U | CE-709U CE-702U |
| | GS-MDP2CU | CE-705AU | GS-MDP2CU CE-705AU |
| | Erosion & Sedimentation | | |
| | YES-4 | YES-7 | |
| | YES-5 | YES-8 | |
| | YES-6 | | |
| Type III Far-Field | Streams | | |
| | F-USGS | | |
| | YUPRYEL | | |
| | Alluvial Aquifer | | |
| | GS-S11 | GS-S24 | GS-S24 |
| | GS-S11A | | |
| | Deep Aquifer | | |
| | GS-M2U | GS-M5U | GS-M3U |
| | GS-M3U | | |
| | Erosion & Sedimentation | | |
| | YES-9 | YES-11 | |
| | YES-10 | | |

## 3. Results and Discussion

Temporal and spatial hydrologic variations have been examined for the MIS program element, using data from stations listed above. Temporal changes were examined by comparing 1982 univariate statistics with similar statistics for previous years, with the major focus on comparison with 1981

data. Extensive repetition of previously reported (pre-1982) data has been avoided. The 1981 data base used for comparison purposes in this report is provided in RBOSC (1982). Spatial variations were evaluated by comparing control, near-field, and far-field univariate statistics for surface streams, alluvial wells and upper aquifer wells. An analysis of variance procedure was used to test the significance of observed variations and space-time interactions.

Unless noted otherwise, the parameters discussed and listed in this section and associated appendices have the following units: water chemistry constituents, milligrams per liter; mercury, micrograms per liter; pH, standard units; conductivity (or ec), micromhos per cm; temperature, degrees Celsius.

## A. Impoundments and Retort Water System

During 1982, the Jeffrey Pond (YJEFFPOND) and West Retention Pond (YWRPOND) received water from the mine sumps and exhibited the water quality of area upper aquifer water. These data are presented in the discussion of the dewatering/reinjection/discharge program (Section 5.1) and will not be repeated here.

The East Retention Pond (YERPOND) is located adjacent to the MIS surface process area and receives runoff, spills, etc. from that area. Changes in mean water quality of the East Retention Pond in 1982 (Table 5-8) as compared to 1981 are as follows (Appendix 5.2-1):

Table 5-8. Summary of Water Quality Data for East Pond, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 3 | 9.87 | 0.15 | 10.00 | 9.70 | 9.70 | 10.00 |
| CONDUCTIVITY | 3 | 5350.00 | 867.47 | 6350.00 | 4800.00 | 4800.00 | 6350.00 |
| TOT DIS SOLIDS | 4 | 4076.25 | 339.59 | 4362.00 | 3611.00 | 3611.00 | 4362.00 |
| ALKALINITY | 4 | 1507.25 | 191.74 | 1688.00 | 1325.00 | 1325.00 | 1688.00 |
| CALCIUM | 4 | 6.82 | 2.99 | 9.60 | 3.90 | 3.90 | 9.60 |
| MAGNESIUM | 4 | 58.00 | 2.94 | 61.00 | 54.00 | 54.00 | 61.00 |
| POTASSIUM | 4 | 2.26 | 0.41 | 2.70 | 1.83 | 1.83 | 2.70 |
| SODIUM | 4 | 1365.00 | 141.54 | 1550.00 | 1240.00 | 1240.00 | 1550.00 |
| BICARBONATE | 4 | 581.00 | 87.90 | 670.00 | 503.00 | 503.00 | 670.00 |
| CARBONATE | 4 | 197.76 | 320.27 | 677.00 | 6.45 | 6.45 | 677.00 |
| CHLORIDE | 4 | 126.17 | 143.64 | 258.20 | 1.74 | 1.74 | 258.20 |
| NITRATE | 4 | 0.30 | 0.24 | 0.60 | -0.10 | 0.10 | 0.60 |
| SULFATE | 4 | 1782.00 | 298.51 | 2043.00 | 1520.00 | 1520.00 | 2043.00 |
| FLUORIDE | 4 | 1.64 | 0.36 | 2.00 | 1.30 | 1.30 | 2.00 |
| AMMONIA | 4 | 0.93 | 1.55 | 3.26 | 0.05 | 0.05 | 3.26 |
| PHOSPHATE | 4 | 0.06 | 0.02 | 0.09 | 0.04 | 0.04 | 0.09 |
| BORON | 4 | 0.24 | 0.03 | 0.27 | 0.21 | 0.21 | 0.27 |
| SILICA | 4 | 34.50 | 49.01 | 108.00 | 9.00 | 9.00 | 108.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 4 | 20.50 | 5.69 | 29.00 | 17.00 | 17.00 | 29.00 |
| ARSENIC | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 4 | 0.02 | 0.01 | 0.03 | 0.01 | 0.01 | 0.03 |
| VANADIUM | 4 | 0.30 | 0.23 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 4 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 4 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 2 | 0.36 | 0.37 | 0.63 | 0.10 | 0.10 | 0.63 |
| CADMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 2 | 0.19 | 0.01 | 0.20 | 0.19 | 0.19 | 0.20 |
| MANGANESE | 2 | 0.07 | 0.01 | 0.08 | 0.06 | 0.06 | 0.08 |
| NICKEL | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 2 | 1.16 | 1.33 | 2.10 | 0.22 | 0.22 | 2.10 |
| TITANIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 2 | 0.03 | 0.04 | 0.06 | 0.01 | 0.01 | 0.06 |
| ZIRCONIUM | 2 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 9.9 | 9.2 | 10.0 | 10.5 |
| ec | 5350 | 3572 | 6350 | 6400 |
| Ca | 7 | 17 | 9.6 | 28 |
| Mg | 58 | 67 | 61 | 86 |
| K | 2.3 | 4.6 | 2.7 | 10.5 |
| Na | 1365 | 1065 | 1550 | 2180 |
| $HCO_3$ | 581 | 558 | 670 | 879 |
| $CO_3$ | 198 | 41 | 677 | 164 |
| Cl | 126 | 182 | 258 | 728 |
| $SO_4$ | 1782 | 1396 | 2043 | 2380 |
| F | 1.64 | 1.00 | 2.00 | 1.86 |
| $NH_3$ | .93 | 7.91 | 3.26 | 14.97 |
| B | .24 | .28 | .27 | .51 |
| DOC | 20.5 | 13.56 | 29 | 23 |

Although the mean values of several parameters (pH, conductivity, sodium, bicarbonate, carbonate, sulfate, fluoride and DOC) increased in 1982 relative to 1981, the maximum values observed during the two years were comparable or the 1982 maxima were lower.

Piezometers 1, 2 and 4 were observed to contain water during 1982. However, the water exhibited conductivities in the 1000 to 1100 micromhos per cm range and pH in the 7.7 to 7.8 range. Thus, no leakage is indicated. Similar water has been observed in these piezometers since 1979 and 1980.

During 1982, the mine sump system for collecting mine water and pumping it to the surface was replaced by submersible pumps, and the mine was placed in a "no-access" mode. Water collected at the bottom of MIS Retort 1 is pumped to the surface using a system separate from the mine-water system.

In September-November, a series of mine-water pump failures resulted in partial flooding of the mine and retort. Water quality data collected during this period (Tables 5-9 and 5-10) show that mine water quality was

Table 5-9. Retort Water Quality Data

| | Sour Water[1/] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 6/22/82 | 7/28/82 | 8/30/82 | 9/28/82 | 10/27/82 | 11/9/82 | 11/16/82 | 11/22/82[2/] | 12/20/82 | 12/29/82 |
| pH | 8.4 | 8.4 | 8.3 | 8.1 | 8.2 | 8.0 | 7.8 | 8.3 | 8.5 | 8.2 |
| ec | 2,480 | 2,300 | 2,400 | 2,360 | 1,610 | 1530 | 2,630 | 3,000 | 3,700 | 3,250 |
| Ca | 14 | 12 | 12 | 96 | 72 | 67 | 174 | 160 | 116 | 84 |
| Mg | 53 | 50 | 50 | 104 | 89 | 88 | 112 | 70 | 58 | 60 |
| Na | 380 | 370 | 390 | 270 | 220 | 220 | 340 | 410 | 550 | 490 |
| K | 32 | 28 | 38 | 14.4 | 5.1 | 2.5 | 120 | 220 | 334 | 216 |
| $HCO_3$ | 1,246 | 1,131 | 1,084 | 659 | 567 | 580 | 472 | 419 | 544 | 715 |
| $SO_4$ | 289 | 288 | 319 | 823 | 576 | 498 | 1,358 | 1,459 | 1,590 | 1,080 |
| Cl | 78.3 | - | 19 | 27 | 11.2 | 8.7 | 14.6 | 57.2 | 61.7 | 76.4 |
| TDS | 1,360 | 1,464 | 1,280 | 1,632 | 1,286 | 1,206 | 2,416 | 2,572 | 3,092 | 2,328 |
| Alk | 1,053 | 975 | 915 | 563 | 483 | 490 | 403 | 366 | 513 | 607 |
| $PO_4$ | .04 | .27 | .03 | .01 | .01 | .02 | <.01 | .02 | .31 | <.01 |
| $NH_3$-N | 83.04 | 82.18 | 20.30 | 52.25 | 7.5 | 2.86 | 9.15 | 12.0 | 21.57 | 17.2 |
| F | 10.58 | 11.8 | 11.4 | 4.1 | 2.4 | 1.9 | 2.9 | 4.8 | 7.5 | 8.2 |
| DOC | 48 | 36 | 36 | 38.5 | 8 | 7 | 12 | 33 | 36 | 23 |
| As | <.01 | .01 | <.01 | .02 | .01 | <0.1 | .01 | .02 | .02 | <.01 |
| B | .40 | .57 | .58 | .38 | .26 | .17 | 1.01 | 1.42 | 2.25 | 1.5 |
| Fe | <.05 | .14 | .07 | .07 | .07 | .24 | .18 | .82 | <.12 | .14 |
| Hg | <.0003 | <.0003 | .0003 | <.0003 | <.0003 | <.0003 | <.0003 | <.0003 | <.0003 | <.0003 |
| Mo | <.1 | <.1 | <.1 | <.1 | <.1 | <.1 | <.1 | 1.1 | <.1 | .2 |
| Se | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | .01 | .02 | .02 |
| $SiO_2$ | 25 | 25 | 27 | 26 | 25 | 25 | 26 | 113 | 26 | 23 |
| V | <.05 | - | - | <.1 | <.1 | <.1 | <.1 | <.1 | <.1 | <.1 |

1/ Sour water is water which has contact with the in situ retort materials; all of these samples were collected after the in situ retorting was terminated.

2/ 11/22/82 sample is for "totals", other analyses or for dissolved constituents.

Table 5-10. Mine Water Quality Data

| | 1980-1981 | | Mine Water | | | |
|---|---|---|---|---|---|---|
| | Maximum | Minimum | 10/27/82 | 11/1/82 | 11/9/82 | 12/20/82 |
| pH | 8.3 | 7.7 | 8.3 | 7.9 | 8.0 | 8.3 |
| ec | 1,500 | 1,300 | 1,370 | 1,300 | 1,600 | 1,340 |
| Ca | 80 | 26 | 46 | 53 | 77 | 44 |
| Mg | 97 | 68 | 83 | 80 | 97 | 81 |
| Na | 230 | 136 | 200 | 180 | 200 | 210 |
| K | 1.3 | 0.39 | .69 | .90 | .81 | .40 |
| $HCO_3$ | 587 | 476 | 539 | 512 | 579 | 571 |
| $SO_4$ | 494 | 320 | 428 | 423 | 535 | 370 |
| Cl | 13.6 | 4.8 | 9.0 | 11.9 | 9.2 | 8.4 |
| TDS | 1,056 | 962 | 1,060 | 978 | 1,260 | 1,014 |
| Alk | 498 | 416 | 466 | 436 | 487 | 483 |
| $PO_4$ | .16 | <.10 | .01 | .03 | .02 | <.01 |
| $NH_3$-N | 1.1 | .1 | <0.05 | .19 | .05 | .13 |
| F | 1.8 | .16 | 1.6 | 1.5 | 1.4 | 1.3 |
| DOC | 11 | 2 | 6 | 3 | 6 | 5 |
| As | <.01 | .01 | <.01 | <.01 | <.01 | <.01 |
| B | .30 | <.05 | <.24 | .20 | .18 | .23 |
| Fe | .33 | <.05 | <.05 | <0.05 | <.05 | <.05 |
| Hg | <.0003 | <.0003 | <.0003 | <.0003 | <.0003 | <.0003 |
| Mo | .1 | .1 | <.1 | <.1 | <.1 | <.1 |
| Se | .01 | .01 | <.01 | <.01 | <.01 | <.01 |
| $SiO_2$ | 30 | 21 | 20 | 22 | 25 | 28 |
| V | <.5 | <.5 | <.1 | <.1 | <.1 | <.1 |

not appreciably impacted by the incident. The November 9, 1982 samples show somewhat decreased concentrations of several major ions and TDS in sour water and similar increases in mine water which are not fully understood. Some contamination or mislabeling of samples may have occurred. The mine and retort water pumping systems were again operational (with additional backup capacity) in November. Water levels are being maintained such that the level in the mine is always above that in the retort.

B. Springs and Seeps

Several spring and seep monitoring stations function as controls for the MIS Area Program. Water chemistry data from these stations are contained in Appendix 5-1.1. Mean and maximum concentrations for major parameters in 1982 (Table 5-11) were comparable to 1981 observations:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.7 | 7.9 | 8.5 | 8.9 |
| ec | 1475 | 1243 | 2100 | 2100 |
| Ca | 98 | 110 | 120 | 140 |
| Mg | 73 | 75 | 120 | 120 |
| K | 1.47 | 1.74 | 4.40 | 2.50 |
| Na | 142 | 135 | 240 | 240 |
| $HCO_3$ | 575 | 545 | 829 | 821 |
| Cl | 14.7 | 19.1 | 34.6 | 43.6 |
| $SO_4$ | 362 | 383 | 603 | 611 |
| F | .33 | .30 | .62 | .37 |
| $NH_3$ | .22 | .84 | .88 | 1.40 |
| B | .24 | .30 | .61 | .45 |
| DOC | 6.5 | 8.1 | 11.0 | 16.0 |

C. Streams

Several near-field stream stations were monitored to examine the effects of MIS operations. Physical and water quality data from these stations are contained in Appendix 5-1.2. These stations include the following:

Table 5-11. Summary of Water Quality Data for Springs and Seeps, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 15 | 7.65 | 0.42 | 8.50 | 6.80 | 6.80 | 8.50 |
| CONDUCTIVITY | 15 | 1475.00 | 338.72 | 2100.00 | 1100.00 | 1100.00 | 2100.00 |
| TOT DIS SOLIDS | 15 | 1013.47 | 306.96 | 1565.00 | 612.00 | 612.00 | 1565.00 |
| ALKALINITY | 15 | 494.60 | 125.54 | 710.00 | 383.00 | 383.00 | 710.00 |
| CALCIUM | 15 | 98.47 | 10.27 | 120.00 | 80.00 | 80.00 | 120.00 |
| MAGNESIUM | 15 | 72.93 | 21.52 | 120.00 | 52.00 | 52.00 | 120.00 |
| POTASSIUM | 15 | 1.47 | 0.93 | 4.40 | 0.84 | 0.84 | 4.40 |
| SODIUM | 15 | 142.13 | 69.63 | 240.00 | 74.00 | 74.00 | 240.00 |
| BICARBONATE | 15 | 575.00 | 154.16 | 829.00 | 417.00 | 417.00 | 829.00 |
| CARBONATE | 15 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 15 | 14.66 | 7.42 | 34.60 | 7.28 | 7.28 | 34.60 |
| NITRATE | 15 | 0.49 | 0.36 | 1.10 | 0.10 | 0.10 | 1.10 |
| SULFATE | 15 | 362.27 | 118.19 | 603.00 | 216.00 | 216.00 | 603.00 |
| FLUORIDE | 15 | 0.33 | 0.12 | 0.62 | 0.19 | 0.19 | 0.62 |
| AMMONIA | 15 | 0.22 | 0.25 | 0.88 | 0.05 | 0.05 | 0.88 |
| PHOSPHATE | 15 | 0.08 | 0.07 | 0.30 | 0.01 | 0.01 | 0.30 |
| BORON | 15 | 0.24 | 0.16 | 0.61 | 0.04 | 0.04 | 0.61 |
| SILICA | 15 | 21.80 | 3.45 | 29.00 | 14.00 | 14.00 | 29.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 15 | 6.47 | 3.14 | 11.00 | 2.00 | 2.00 | 11.00 |
| ARSENIC | 15 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 15 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 15 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 15 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 15 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |

- YBOXFL - on Box Elder Gulch
- YCOFL - on Corral Gulch upstream from the confluence with Box Elder Gulch
- YMET3 - on Corral Gulch below the confluence with Box Elder Gulch
- YSEOFL - on Corral Gulch approximately 1.5 miles below YMET3

The 1982 data for conductivity at YMET3 and at YSEOFL are plotted in Figures 5-5, and 5-6. The flow at YBOXFL varied from 157 to 588 gallons per minute during 1982, with an average flow of 234.7 gpm (compared to 286.7 gpm in 1981). The 1982 mean conductivity at YBOXFL was 1351 micromhos per cm as compared to 1406 micromhos per cm in 1981. The maximum conductivities for the two years were comparable as was the pH.

The 1982 flows at the SEO flume (YSEOFL) ranged from 76.3 to 426 gallons per minute with a mean of 152.5 gallons per minute. The conductivity ranged from 925 to 2050 micromhos per cm with a mean of 1902 (compared to a mean of 1892 micromhos per cm for 1981).

The surface flow at YCOFL exhibited conductivity of 1400 to 1700 micromhos per cm in 1982, somewhat greater than levels observed in Box Elder Gulch (at YBOXFL). The pH levels were comparable in the two watersheds. The conductivity at YMET3 ranged from 900 to 1500 with a mean of 1395 micromhos per cm during 1982. These levels were comparable to or slightly lower than those observed in 1981.

The leading edge is the location of the maximum extent of surface flow in Yellow Creek below the 24 Road crossing. This position ranged from 0.2 to 2.5 miles during 1982 (Appendix 5-1.2).

The 1982 water quality observed at YBOXFL and YMET3 was very similar and the 1982 data were similar to 1981 observations at these sites. The concentrations of most major inorganic constituents increased appreciably between YMET3 and YSEOFL, located downstream (Tables 5-12 and 5-13):

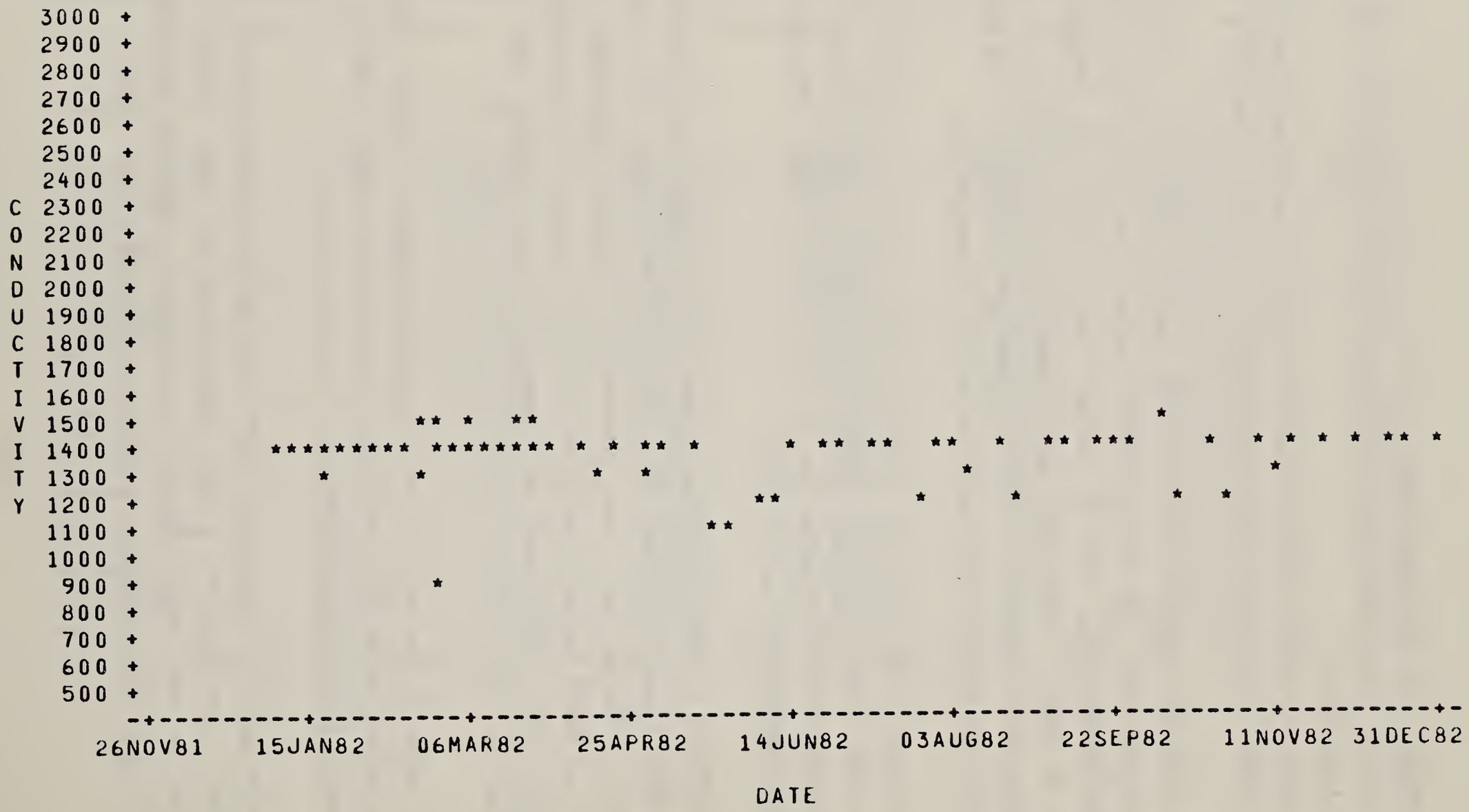


Figure 5-5. Conductivity (micromhos per cm) at YMET3, 1982

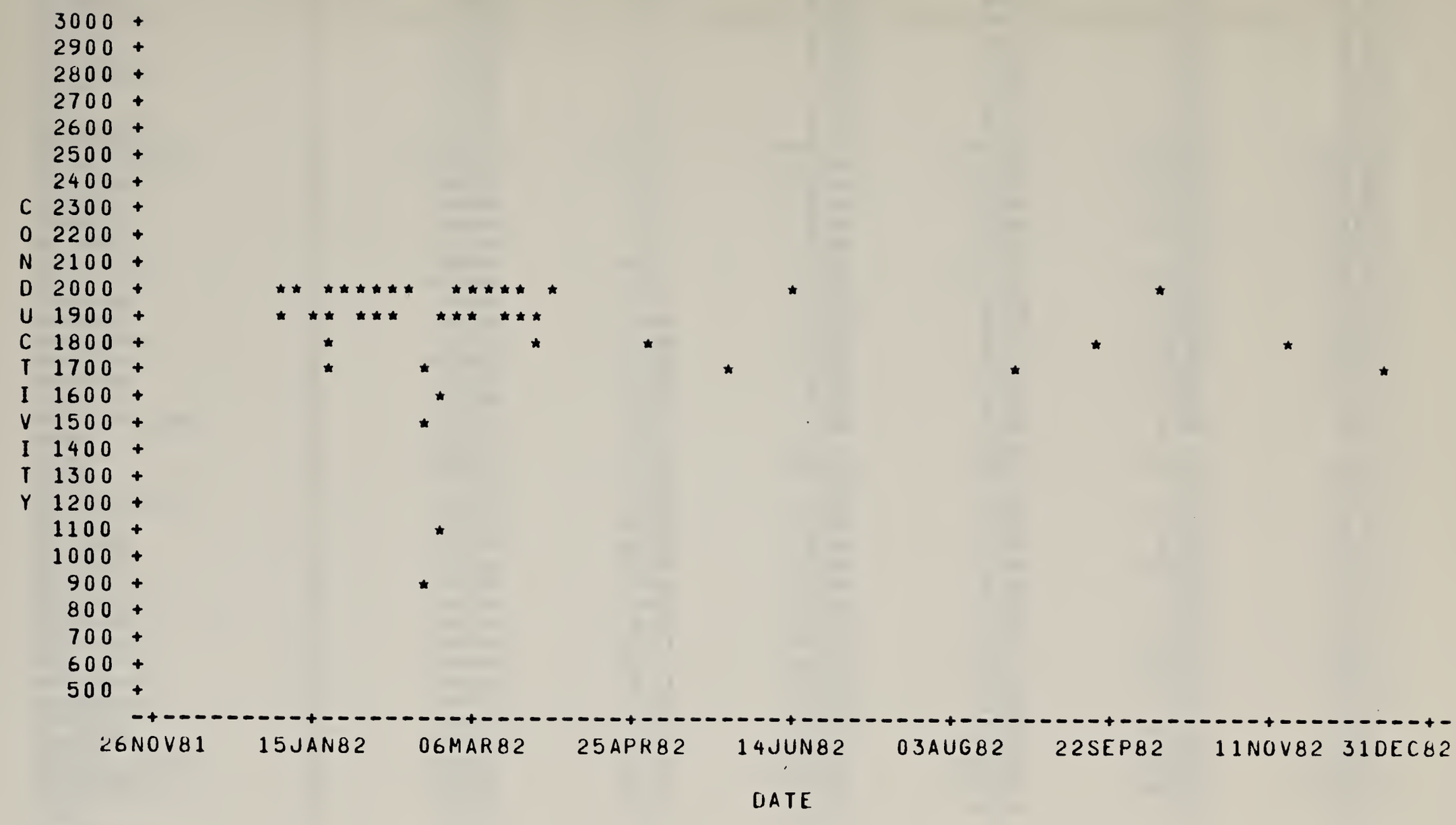


Figure 5-6. Conductivity (micromhos per cm) at YSEOFL, 1982

Table 5-12. Summary of Water Quality Data for Surface Flow Station YMET3, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 5 | 8.04 | 0.25 | 8.40 | 7.80 | 7.80 | 8.40 |
| CONDUCTIVITY | 5 | 1420.00 | 57.01 | 1500.00 | 1350.00 | 1350.00 | 1500.00 |
| TOT DIS SOLIDS | 5 | 982.60 | 49.38 | 1052.00 | 930.00 | 930.00 | 1052.00 |
| ALKALINITY | 5 | 465.60 | 13.07 | 478.00 | 448.00 | 448.00 | 478.00 |
| CALCIUM | 5 | 80.00 | 4.47 | 86.00 | 74.00 | 74.00 | 86.00 |
| MAGNESIUM | 5 | 66.80 | 3.03 | 71.00 | 63.00 | 63.00 | 71.00 |
| POTASSIUM | 5 | 1.33 | 0.07 | 1.41 | 1.24 | 1.24 | 1.41 |
| SODIUM | 5 | 166.00 | 11.40 | 180.00 | 150.00 | 150.00 | 180.00 |
| BICARBONATE | 5 | 549.60 | 18.81 | 569.00 | 525.00 | 525.00 | 569.00 |
| CARBONATE | 5 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 5 | 10.62 | 0.66 | 11.10 | 9.52 | 9.52 | 11.10 |
| NITRATE | 5 | 0.12 | 0.04 | 0.20 | 0.10 | 0.10 | 0.20 |
| SULFATE | 5 | 350.78 | 31.25 | 382.00 | 305.00 | 305.00 | 382.00 |
| FLUORIDE | 5 | 0.70 | 0.18 | 0.92 | 0.51 | 0.51 | 0.92 |
| AMMONIA | 5 | 0.08 | 0.06 | 0.18 | 0.05 | 0.05 | 0.18 |
| PHOSPHATE | 5 | 0.06 | 0.04 | 0.13 | 0.03 | 0.03 | 0.13 |
| BORON | 5 | 0.20 | 0.08 | 0.31 | 0.10 | 0.10 | 0.31 |
| SILICA | 5 | 23.80 | 0.45 | 24.00 | 23.00 | 23.00 | 24.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 5 | 5.10 | 3.71 | 9.00 | 1.00 | 1.00 | 9.00 |
| ARSENIC | 5 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 5 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 5 | 0.42 | 0.18 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 5 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 5 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 1 | 0.96 | . | 0.96 | 0.96 | 0.96 | 0.96 |
| CADMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 1 | 0.03 | . | 0.03 | 0.03 | 0.03 | 0.03 |
| MANGANESE | 1 | 0.08 | . | 0.08 | 0.08 | 0.08 | 0.08 |
| NICKEL | 1 | 0.05 | . | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 1 | 2.27 | . | 2.27 | 2.27 | 2.27 | 2.27 |
| TITANIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 1 | 10.00 | . | 10.00 | 10.00 | 10.00 | 10.00 |

Table 5-13. Summary of Water Quality Data for Surface Flow Station YSEOFL, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 5 | 7.80 | 0.32 | 8.10 | 7.30 | 7.30 | 8.10 |
| CONDUCTIVITY | 5 | 1820.00 | 201.87 | 2050.00 | 1500.00 | 1500.00 | 2050.00 |
| TOT DIS SOLIDS | 5 | 1379.60 | 128.83 | 1468.00 | 1156.00 | 1156.00 | 1468.00 |
| ALKALINITY | 5 | 580.00 | 72.12 | 670.00 | 474.00 | 474.00 | 670.00 |
| CALCIUM | 5 | 103.20 | 7.40 | 110.00 | 92.00 | 92.00 | 110.00 |
| MAGNESIUM | 5 | 104.20 | 11.54 | 120.00 | 88.00 | 88.00 | 120.00 |
| POTASSIUM | 5 | 2.62 | 0.64 | 3.50 | 1.71 | 1.71 | 3.50 |
| SODIUM | 5 | 204.00 | 24.08 | 230.00 | 170.00 | 170.00 | 230.00 |
| BICARBONATE | 5 | 684.00 | 86.21 | 791.00 | 557.00 | 557.00 | 791.00 |
| CARBONATE | 5 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 5 | 19.88 | 2.74 | 23.80 | 16.40 | 16.40 | 23.80 |
| NITRATE | 5 | 0.20 | 0.14 | 0.40 | 0.10 | 0.10 | 0.40 |
| SULFATE | 5 | 556.98 | 40.53 | 604.00 | 497.00 | 497.00 | 604.00 |
| FLUORIDE | 5 | 0.52 | 0.19 | 0.75 | 0.34 | 0.34 | 0.75 |
| AMMONIA | 5 | 0.08 | 0.05 | 0.17 | 0.04 | 0.04 | 0.17 |
| PHOSPHATE | 5 | 0.07 | 0.04 | 0.13 | 0.03 | 0.03 | 0.13 |
| BORON | 5 | 0.26 | 0.14 | 0.40 | 0.04 | 0.04 | 0.40 |
| SILICA | 5 | 20.80 | 3.83 | 26.00 | 17.00 | 17.00 | 26.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 5 | 12.12 | 2.42 | 14.00 | 8.00 | 8.00 | 14.00 |
| ARSENIC | 5 | 0.01 | 0.01 | 0.03 | 0.01 | 0.01 | 0.03 |
| SELENIUM | 5 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 5 | 0.42 | 0.18 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 5 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 5 | 0.46 | 0.36 | 1.10 | 0.30 | 0.30 | 1.10 |
| ALUMINUM | 1 | 0.20 | . | 0.20 | 0.20 | 0.20 | 0.20 |
| BARIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 1 | 0.66 | . | 0.66 | 0.66 | 0.66 | 0.66 |
| CADMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 1 | 0.02 | . | 0.02 | 0.02 | 0.02 | 0.02 |
| MANGANESE | 1 | 0.03 | . | 0.03 | 0.03 | 0.03 | 0.03 |
| NICKEL | 1 | 0.05 | . | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 1 | 2.54 | . | 2.54 | 2.54 | 2.54 | 2.54 |
| TITANIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 1 | 10.00 | . | 10.00 | 10.00 | 10.00 | 10.00 |

| Parameter | YMET3 1982 Mean | SEOFL 1982 Mean |
|---|---|---|
| pH | 8.3 | 7.8 |
| TDS | 960 | 1380 |
| Alkalinity | 464 | 580 |
| Calcium | 76 | 103 |
| Magnesium | 66 | 104 |
| Sodium | 157 | 204 |
| Bicarbonate | 546 | 684 |
| Chloride | 12 | 20 |
| Sulfate | 323 | 557 |
| DOC | 8 | 12 |

Most of the increase in dissolved solids is due to sodium and sulfate concentrations, with calcium, magnesium, bicarbonate, and chloride concentrations contributing to a lesser extent. Most of the increased dissolved solids load is probably due to spring discharges just upstream from SEOFL.

MANOVA techniques were used to evaluate the temporal variability (comparison of 1981 and 1982) at these stream stations. The results are summarized as follows:

- o YBOXFL - no significant variability except for fluoride (PR > F = 0.0377)
  - Duncan's means for fluoride were: 1981, 0.12 mg/l; 1982, 0.64 mg/l
- o YCOFL - station established in 1982, insufficient data for analysis
- o YMET3 - no significant variability except for alkalinity (PR > F = 0.0323)
  - Duncan's means for alkalinity were: 1981, 495 mg/l; 1982, 466 mg/l
- o YSEOFL - no significant variability for any parameter tested

Data collected at USGS gage stations includes daily values of flow, conductivity, temperature and sediment (Appendix 5-2.1). Sediment data were not available for this report. Other data were available through September 1982.

Table 5-14 shows a general water balance for Tract C-a, developed using USGS gage station data. As observed in previous years, the tract area is a net producer of water (i.e. more water leaves than flows onto the tract).

As is typical, flow at the gage stations was quite variable. Station A (Dry Fork) was dry for most of the 1982 report year; flow was recorded on only nine days during 1982. The maximum daily mean flow was 0.75 cfs in August. The daily maximum conductivity observed at Station A ranged from 660 to 1020 micromhos per cm.

Flow at Station B (Corral Gulch near the west boundary of Tract C-a) ranged from zero to 0.75 cfs as a daily mean during 1982. Most of the flow was observed in the June through August period (Figure 5-7). During periods of flow, the conductivity at this gage was fairly steady, with a mean of 1128 and range of 1030 to 1330 micromhos per cm. The means for the 1980 and 1981 report years were 1243 and 1204 micromhos per cm, respectively. Analysis of variance results indicated that conductivity and flow at Stations B and C were significantly different among report years. The results of the Duncan's Multiple Range test (Appendix 5-2.1) indicated that for Station B the 1982 mean flow was not significantly different from 1980 and 1974 but was different from the other years of record. The data indicate that 1982 was a moderate flow year with a mean (from the Duncan's test results) of 0.25 cfs whereas the maximum and minimum year means of record were 0.36 cfs (1979) and 0.04 cfs (1977).

The daily mean conductivity levels at Station B during 1982 were not significantly different from those of 1975, 1979, 1980 and 1981. It was significantly different from 1976 through 1978. For this group of years including 1982 the Duncan's means ranged from 1020 (1975) to 1154 (1980) micromhos per cm (Appendix 5-2.1).

Table 5-14. Summary of flows at USGS Gaging Stations 1982 Water Year

| Station | Flow (acre/ft during month) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JNE | JLY | AUG | SEPT |
| A-Dry Fork | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.5 | 1.0 |
| B-Corral Gulch - West | 15.0 | 17.0 | 7.7 | 7.5 | 9.6 | 5.7 | 1.7 | 4.2 | 27.0 | 31.0 | 27.0 | 22.0 |
| C-Box Elder - West | 1.5 | 0.0 | 0.0 | 0.0 | 3.1 | 0.4 | 11.0 | 38.0 | 8.5 | 0.0 | 0.0 | 0.1 |
| E-Box Elder tributary | 1.6 | 0.0 | 0.0 | 0.0 | 6.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Total Inflow | 18.4 | 17.0 | 7.7 | 7.5 | 19.3 | 6.1 | 12.7 | 42.2 | 35.5 | 31.2 | 28.5 | 23.2 |
| D-Corral Gulch East (total outflow) | 70.0 | 49.0 | 36.0 | 28.0 | 49.0 | 41.0 | 40.0 | 59.0 | 51.0 | 57.0 | 45.0 | 39.0 |
| Outflow-Inflow | 51.6 | 32.0 | 28.3 | 20.5 | 29.7 | 34.9 | 27.3 | 16.8 | 15.5 | 25.8 | 16.5 | 15.8 |

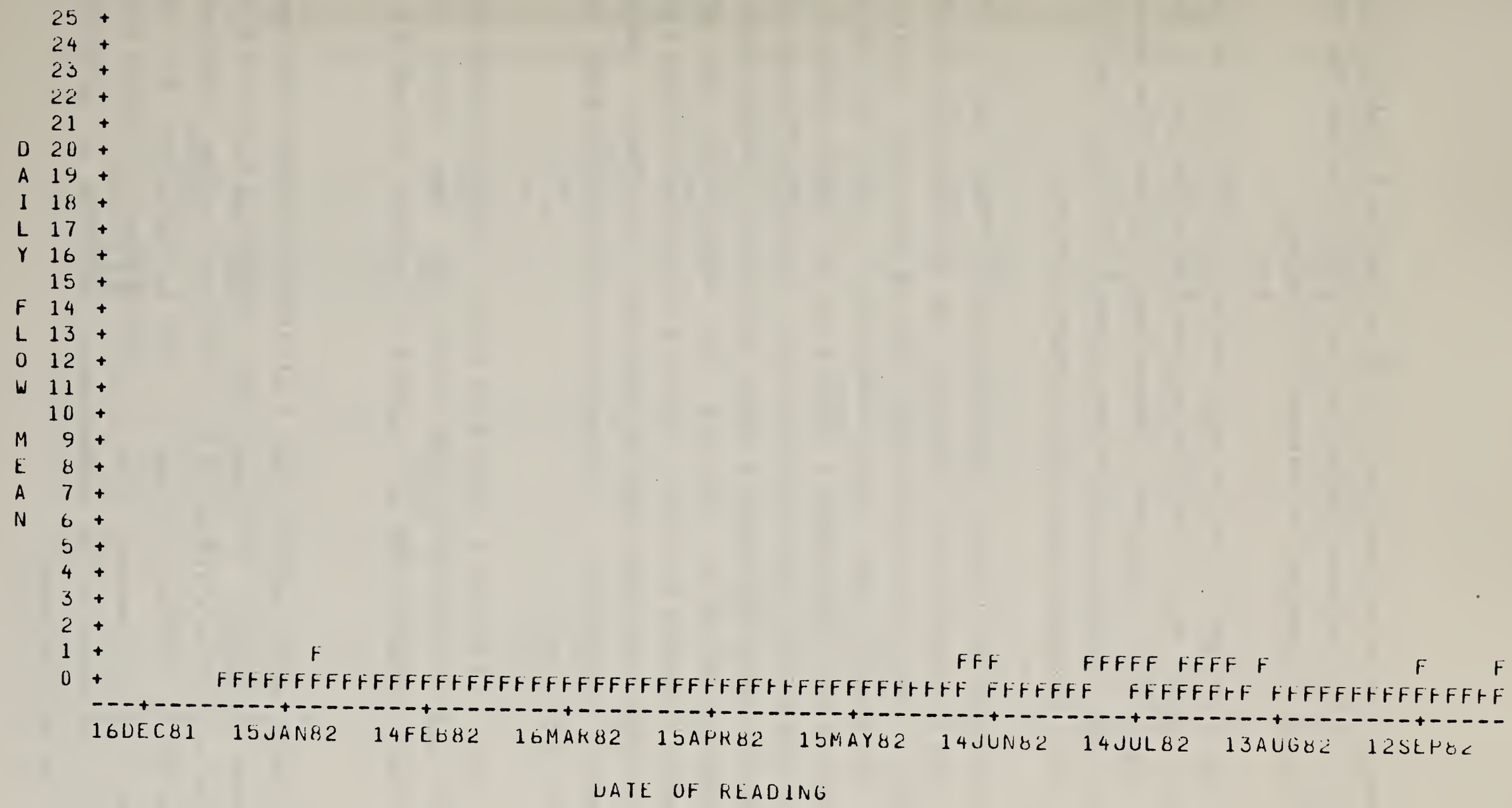


Figure 5-7. Daily Mean Flow (cfs) at USGS Station B, 1982

The water chemistry data collected during 1982 at Station B (Table 5-15) was comparable to 1981 observations and was not greatly changed from 1974 and 1975. This was as expected for this control station.

Station C (Box Elder Gulch near the west boundary of Tract C-a) was also dry for much of 1982. Most of the flow occurred during the April - June period and was related to snow melt. The maximum daily mean flow observed was 0.94 cfs in May. During periods of flow, conductivity (daily maximum) ranged from 570 to 870 with a mean of 805 micromhos per cm.

The Duncan's analysis for Station C indicated that the mean flow for 1982 (0.11 cfs) was not significantly different from that for 1976 and 1981 (Appendix 5-2.1). This is a low to moderate level of flow. For the years of record, the Duncan's means ranged from 0.007 cfs (1977) to 0.46 cfs (1979) (Appendix 5-2.1). The Duncan's analysis for daily mean conductivity showed that 1982 was not significantly different from 1975, 1978 and 1979. For this group of years, the Duncan's means for Station C ranged from 632 to 758 micromhos per cm for 1978 and 1979, respectively. One water chemistry sample (Appendix 5-2.1) was collected at Station C during 1982. The TDS of 569 mg/l was greater than the 1981 mean of 432.5 mg/l. However, the difference is not excessive, as comparable or greater annual means have been observed at this gage.

Flow was observed at Station E (Rinky Dink Gulch, a tributary of Box Elder Gulch) during only 11 days of the 1982 report year. Most of the flow observed through September 1982 was recorded in February and was due to snow melt.

Station D (Corral Gulch east of Tract C-a) flowed throughout the report period (through September). Daily mean flows ranged from 0.37 to 2.2 cfs with a mean of 0.76 cfs (Figure 5-8). The daily maximum conductivity ranged from 880 to 1639 with a mean of 1418 micromhos per cm. Mean conductivity (for daily maximum values) for 1980 and 1981 at Station D were 1487 and 1483 micromhos per cm respectively, indicating no appreciable change over the past few years.

Table 5-15. Water Quality Data for USGS Station B, Corral Gulch, West of Tract C-a, 1982.

| OBS | DATE | TURB70 | TURB76 | COLOR | SP_COND | DO | BOD | COD | PH | CO2 | ALK | HCO3 | CO3 | OIL550 | OIL556 | N_TOT | N_DIS | TORG | ORG | NH3 | TNH3 | NO2_DIS | NO3_DIS | KJEL623 | KJEL625 | TN00303 | NN00203 | TP004 | TOT_P | DIS_P | DORTHOP | TOC | DOC | SUSP_OC | CYANIDE | THS | HS | THARD | NCHARD | CA | MG | NA | SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18FEB82 | . | . | . | 1100 | 9.9 | . | 8 | 8.3 | . | 340 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 6.2 | . | . | . | . | . | . | . | . | . | . | . |
| 2 | 24MAY82 | 7 | . | . | 1150 | 6.4 | . | . | 8.3 | . | 277 | . | . | . | . | . | . | . | 1 | 1.1 | . | . | . | . | . | . | . | . | . | . | -0.01 | . | . | 6.5 | . | -0.01 | -0.5 | . | 490 | 150 | 94 | 63 | 87 | 1.9 |
| 3 | 16SEP82 | . | . | . | 1140 | 9.0 | . | 8 | 8.3 | . | 341 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 5.9 | . | . | . | . | 450 | . | 77 | 63 | 88 | 2.0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 500 | . | 96 | 62 | 87 | 1.9 |

| OBS | PER_NA | NA_K | K | CL | SO4 | F | SIO2 | ABS | BAE | BEI | B | CD | CRU | CUE | FEB | PBN | MNL | MON | NIG | AGV | ZNN | SNL | AGA | GLE | LEI | STE | TEI | ZRR | ODO | TCOLI | FCOLI | PHENOL | PCB | TDS | TDS2 | TDS3 | NH3 | NO32 | NO2 | BR | HG | SR | FLOW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 28 | . | 1.4 | 7.5 | 300 | 0.3 | 22 | . | . | . | 90 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0 | 780 | 0.08 | 1.1 | . | . | . | . | . | . | . | 0.04 |
| 2 | . | . | 1.5 | 7.5 | 300 | 0.3 | 22 | 4 | . | . | 110 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 5 | . | . | . | -1 | . | 749 | . | 1.0 | 0.06 | . | . | -0.01 | -0.1 | . | 0.05 |
| 3 | . | . | 1.0 | 7.8 | 290 | 0.2 | . | . | . | . | 170 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 0.28 |

REPORT YEAR=1982 STAT=C-BOX ELDER GULCH - WEST

| OBS | DATE | TURB70 | TURB76 | COLOR | SP_COND | DO | BOD | COD | PH | CO2 | ALK | HCO3 | CO3 | OIL550 | OIL556 | N_TOT | N_DIS | TORG | ORG | NH3 | TNH3 | NO2_DIS | NO3_DIS | KJEL623 | KJEL625 | TN00303 | NN00203 | TP004 | TOT_P | DIS_P | DORTHOP | TOC | DOC | SUSP_OC | CYANIDE | THS | HS | THARD | NCHARD | CA | MG | NA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 15APR82 | 300 | . | . | 835 | 8.8 | . | . | 8.2 | . | 290 | . | . | 0 | . | . | . | . | 0.67 | 0.75 | . | . | . | . | . | . | . | . | . | -0.01 | . | . | 10 | . | -0.01 | -0.5 | . | 360 | . | 67 | 47 | 60 |

| OBS | SAR | PER_NA | NA_K | K | CL | SO4 | F | SIO2 | ABS | BAE | BEI | B | CD | CRU | CUE | FEB | PBN | MNL | MON | NIG | AGV | ZNN | SNL | AGA | GLE | LEI | STE | TEI | ZRR | ODO | TCOLI | FCOLI | PHENOL | PCB | TDS | TDS2 | TDS3 | NH3 | NO32 | NO2 | BR | HG | SR | FLOW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1.5 | . | . | 1.5 | 5.7 | 190 | 0.3 | 23 | 6 | . | . | 60 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 5 | . | . | . | . | 1 | . | 569 | 1 | 0.77 | 0.08 | . | . | -0.01 | -0.1 | . | 0.19 |

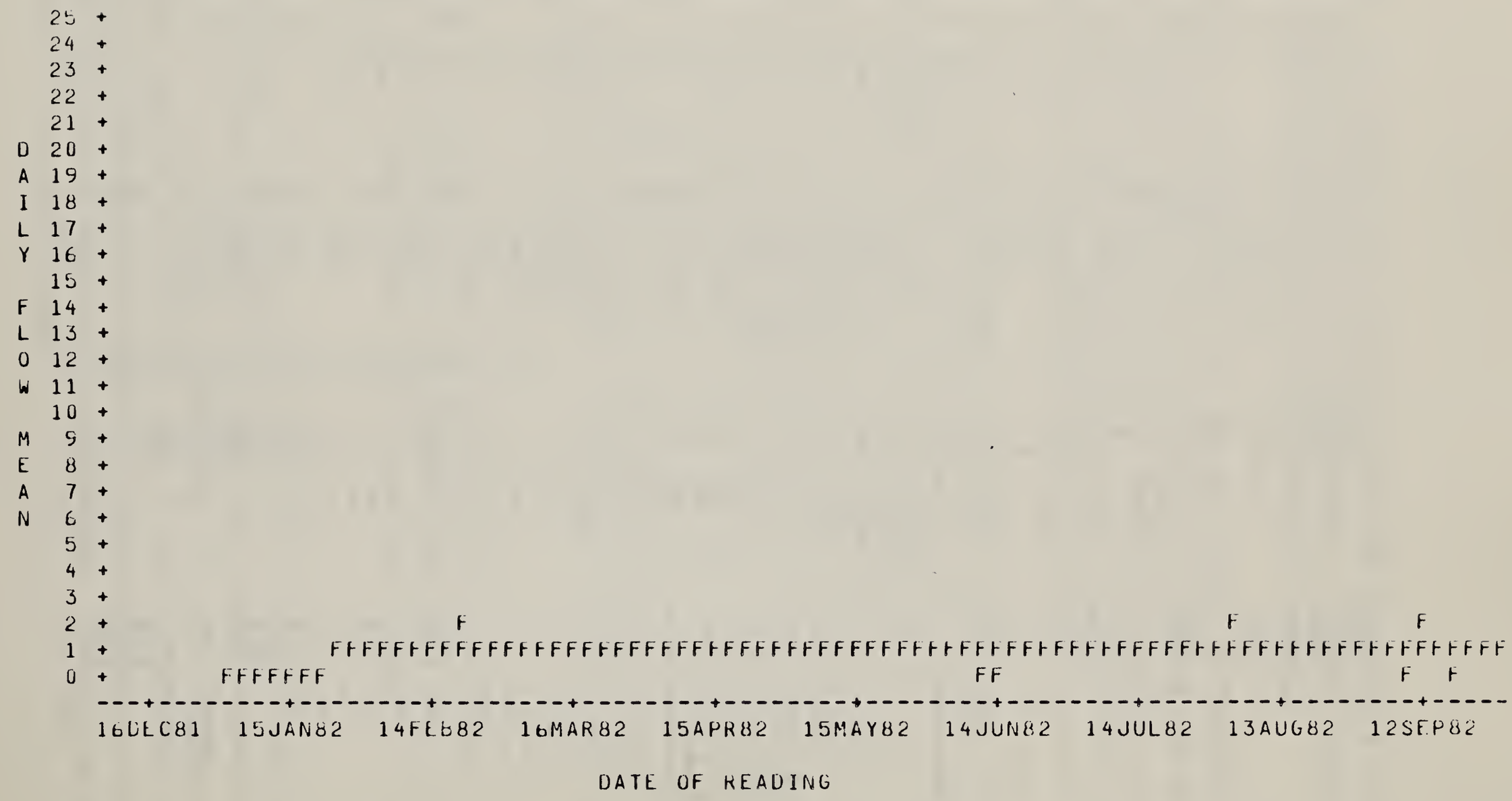


Figure 5-8. Daily Mean Flow (cfs) at USGS Station D, 1982

The Duncan's analysis for Station D showed that for daily mean flows, 1982 was not significantly different from 1980 and 1974 but was different from the other years of record (Appendix 5-2.1). The Duncan's mean for 1982 was 0.76 cfs, while the maximum and minimum annual means for the years of record were 3.65 cfs (1979) and 0.34 cfs (1977). The 1979 mean was influenced by the discharge of mine water. Overall, 1982 was typical of years not influenced by surface discharge from tract operations.

The Duncan's analysis of daily mean conductivity showed that 1982 was different from all other years of record (Appendix 5-2.1) with a mean of 1377 micromhos per cm. The Duncan's analysis means for the years of record ranged from 1055 (1977) to 1455 (1981) micromhos per cm. The results of the Duncan's analyses indicate a low variance within years. For example, a mean difference of about 50 micromhos per cm was significant in some instances. The 1982 water quality data (Table 5-16) was comparable to 1981 observations with respect to maximum concentrations. Mean concentrations for 1982 were comparable to or lower than for 1981. No trends over time were apparent.

Flows at Station F (Yellow Creek) ranged from 0.94 to 54 cfs during 1982 with the maximum flow in February. Conductivity decreased during this peak flow to less than 600 micromhos per cm. The mean daily maximum conductivity for 1982 was 3553 micromhos per cm, which is comparable to earlier years.

The Duncan's analysis of daily mean flow at Station F showed no significant differences among the years of record. This was probably due to the high variability in flow within years. The mean flow for 1982 was relatively high at 2.5 cfs. The 1980 mean was also 2.5 cfs and that for 1974 was 2.4. The conductivity analysis indicated that 1982 was not significantly different from 1975, 1976, and 1981. The means for this group of years ranged from 3399 (1981) to 3468 (1976) micromhos per cm.

As usual, water chemistry at Station F (Appendix 5-2.1) was quite variable during 1982. For example, the conductivity measured in grab samples ranged

Table 5-16. Water Quality Data for USGS Station D, Corral Gulch, West of Tract C-a, 1982.

| OBS | DATE | TURB70 | TUR76 | COLOR | SP_COND | DO | BOD | COD | PH | CO2 | ALK | HCO3 | CO3 | OIL550 | OIL556 | N_TOT | N_DIS | TORG_N | ORG_N | NH3_N | TNH3_N | NO2_DIS | NO3_DIS | KJEL623 | KJEL625 | TN00N3 | NO2NO3 | TP04 | O_P04 | TOT_P | DIS_P | DORTHOP | TOC | DOC | SUSP_OC | CYANIDE | THS | HS | T_HARD | NC_HARD | CA | MG | NA | SAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 20JAN82 | . | . | . | 1510 | 6.5 | . | 7 | 7.8 | . | 480 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4.0 | . | . | . | . | 500 | 20 | 85 | 70 | 170 | 3.8 |
| 7 | 18FEB82 | . | . | . | 1320 | 5.6 | . | 7 | 7.9 | . | 470 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4.9 | . | . | . | . | 480 | 10 | 80 | 68 | 170 | 3.8 |
| 8 | 24MAR82 | . | . | . | 1400 | 6.6 | . | 7 | 7.8 | . | 380 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4.3 | . | . | . | . | 450 | 71 | 75 | 64 | 160 | 3.7 |
| 9 | 14APR82 | . | . | . | 1450 | 6.0 | . | 7 | 7.7 | . | 440 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 5.8 | . | . | . | . | 470 | 32 | 80 | 66 | 160 | 3.6 |
| 10 | 24MAY82 | 210 | . | . | 1250 | 6.0 | . | . | 8.0 | . | 336 | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | -0.01 | . | 4.9 | . | -0.01 | 1.2 | . | 440 | . | 74 | 61 | 120 | 2.8 |
| 11 | 09JUN82 | . | . | . | 1300 | 5.8 | . | 7 | 7.9 | . | 407 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4.5 | . | . | . | . | 450 | . | 76 | 64 | 140 | 3.3 |
| 12 | 29JUL82 | . | . | . | 1400 | 6.1 | . | 7 | 7.9 | . | 295 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 5.0 | . | . | . | . | 430 | . | 60 | 67 | 160 | 3.9 |
| 13 | 16SEP82 | . | . | . | 1400 | 6.8 | . | 7 | 7.9 | . | 342 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4.2 | . | . | . | . | 490 | . | 81 | 69 | 160 | 3.6 |

| OBS | PER_NA | NA_K | K | CL | SO4 | F | SIO2 | AS | BAE | BBE | BBI | B | CD | CCR | CUE | FE | PB | MN | MONL | NI | AG | V | ZN | SN | AL | AGE | GE | LI | LSE | TI | ZR | ODOR | TCOLI | FCOLI | PHENOL | PCB | TDS | TDS2 | TDS3 | NH3 | NO3 | NO2 | BR | HG | SR | FLOW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 42 | . | 1.4 | 11.0 | 380 | 0.7 | 24 | . | . | . | . | 140 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1030 | 1.1 | 1.4 | . | . | . | . | . | . | 0.40 |
| 7 | 43 | . | 1.7 | 9.9 | 380 | 0.6 | 24 | . | . | . | . | 140 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1020 | 1.7 | 1.4 | . | . | . | . | . | . | 0.62 |
| 8 | 44 | . | 1.4 | 10.0 | 390 | 0.6 | 23 | . | . | . | . | 140 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 953 | 1.3 | 1.3 | . | . | . | . | . | . | 0.50 |
| 9 | 42 | . | 1.6 | 9.9 | 360 | 0.7 | 23 | . | . | . | . | 140 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 966 | 2.0 | 1.3 | . | . | . | . | . | . | 0.75 |
| 10 | . | . | 1.6 | 8.8 | 290 | 0.5 | 24 | 5 | . | . | . | 120 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | . | . | . | . | 1 | . | 845 | . | 1.2 | -0.06 | . | . | 63 | -0.1 | . | 0.94 |
| 11 | . | . | 1.4 | 9.7 | 320 | 0.7 | 23 | . | . | . | . | 120 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 880 | 1.7 | 1.2 | . | . | . | . | . | . | 0.89 |
| 12 | . | . | 1.7 | 9.8 | 380 | 0.5 | 24 | . | . | . | . | 180 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 881 | 2.3 | 1.2 | . | . | . | . | . | . | 0.89 |
| 13 | . | . | 1.5 | 10.0 | 370 | 0.5 | 24 | . | . | . | . | 220 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 922 | . | 1.3 | . | . | . | . | . | . | 0.54 |

from 460 to 3200 micromhos per cm. The maximum concentrations of major constituents observed in 1982 were comparable to, though slightly lower than, observed in 1981 and were considerably lower than levels observed in 1974.

## D. Alluvial Aquifers

1. Field Data - Mean water levels (depth to water) at alluvial aquifer control wells during 1982 (Table 5-17) were somewhat greater than 1981 levels, indicating somewhat dryer conditions. However, minimum and maximum water levels for 1982 were comparable to 1981 observations. Water levels for 1982 at GS-S8 are shown in Figure 5-9. The rise shown in the spring is typical of spring runoff and recharge of the alluvial system.

The field data for near-field alluvial wells for 1982 were generally comparable to 1981. Mean water levels in 1982 (27.6 feet) were only slightly more shallow than the 1981 mean (28.1 feet). The water levels for GS-S24 were steady during 1982 (Figure 5-10). Conductivities were slightly elevated in 1982 relative to 1981; the means were 1520 and 1459 micromhos per cm for 1982 and 1981, respectively.

Mean water levels at alluvial aquifer far-field wells were somewhat deeper in 1982 than in 1981 but minimum and maximum values were not greatly different. Water levels at GS-S27S were steady throughout 1982 (Figure 5-11). The mean conductivity in far-field wells during 1982 was somewhat lower than was observed in 1981, but not appreciably so.

Most of the spatial variation in water levels across the control, near-field and far-field areas (Table 5-17) is due to differences in well location and alluvial thickness. The alluvial well pH shows essentially no variation across the three monitoring areas. Conductivity, as observed previously (RBOSC, 1982), increases in the down-gradient direction.

2. Water Quality Data - Water quality data for alluvial wells is presented in Appendix 5-2.6. As previously reported (RBOSC, 1982), the

Table 5-17. Summary of Field Data from Alluvial Wells, MIS Monitoring Program, 1982.

TYPE=ALLUVIAL AQUIFER AREA=CONTROL REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 62 | 33.39 | 8.56 | 43.60 | 21.00 | 21.54 | 48.40 |
| TEMPERATURE | 25 | 8.10 | 0.90 | 9.80 | 6.30 | 6.36 | 9.62 |
| CONDUCTIVITY | 25 | 1151.00 | 120.65 | 1300.00 | 900.00 | 915.00 | 1300.00 |
| PH | 25 | 7.54 | 0.14 | 7.70 | 7.10 | 7.13 | 7.70 |

TYPE=ALLUVIAL AQUIFER AREA=NEAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 101 | 27.57 | 1.18 | 29.20 | 25.60 | 25.80 | 29.00 |
| TEMPERATURE | 16 | 8.55 | 1.17 | 10.50 | 6.90 | 6.90 | 10.50 |
| CONDUCTIVITY | 16 | 1520.31 | 52.61 | 1600.00 | 1450.00 | 1450.00 | 1600.00 |
| PH | 16 | 7.59 | 0.15 | 7.90 | 7.30 | 7.30 | 7.90 |

TYPE=ALLUVIAL AQUIFER AREA=FAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 10 | 9.95 | 0.28 | 10.40 | 9.60 | 9.60 | 10.40 |
| TEMPERATURE | 6 | 8.18 | 0.67 | 9.30 | 7.60 | 7.60 | 9.30 |
| CONDUCTIVITY | 6 | 1808.33 | 91.74 | 1900.00 | 1700.00 | 1700.00 | 1900.00 |
| PH | 6 | 7.52 | 0.28 | 7.90 | 7.20 | 7.20 | 7.90 |

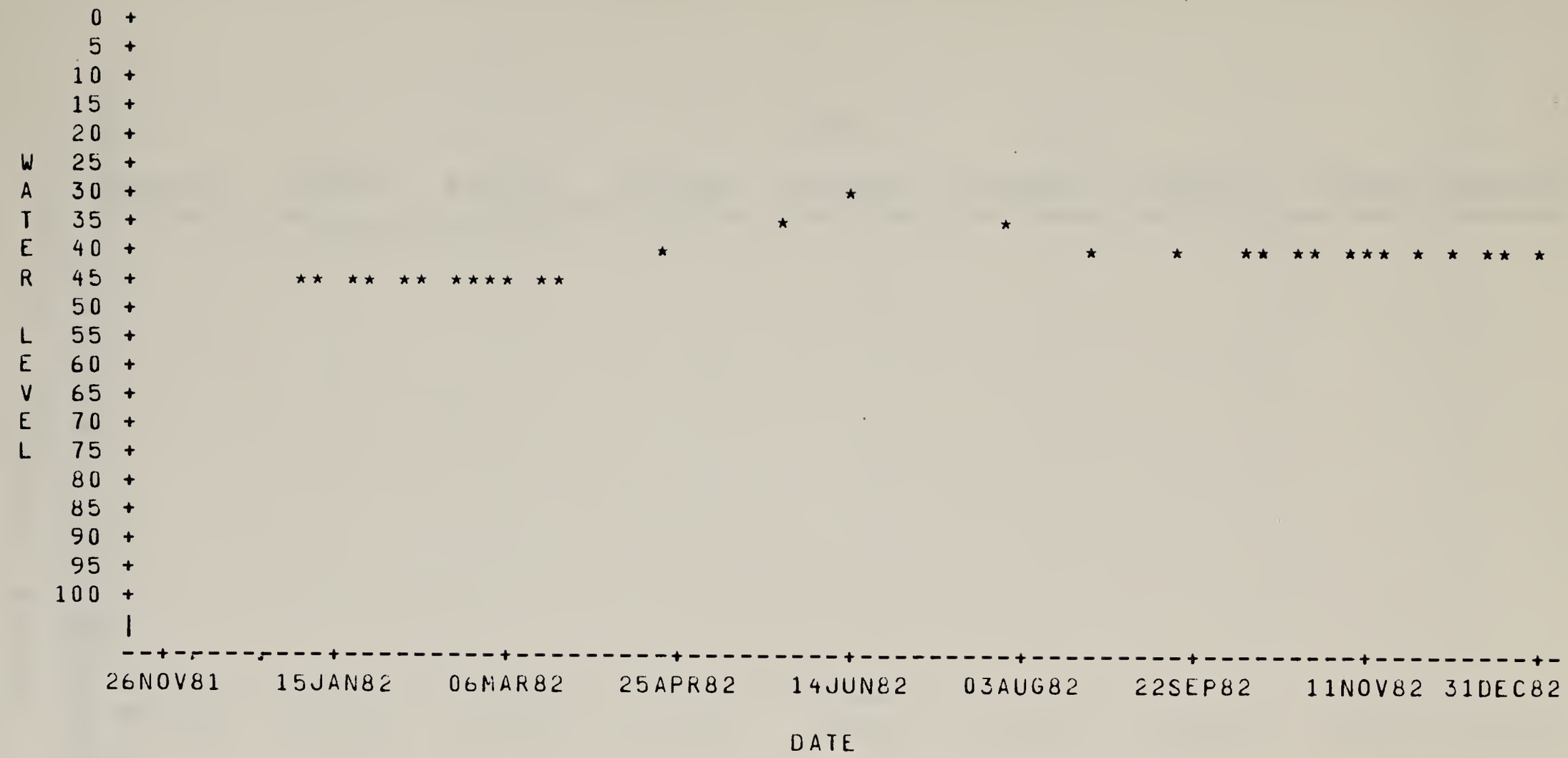


Figure 5-9. Water Levels (feet below surface) at Alluvial Well GS-S8, 1982

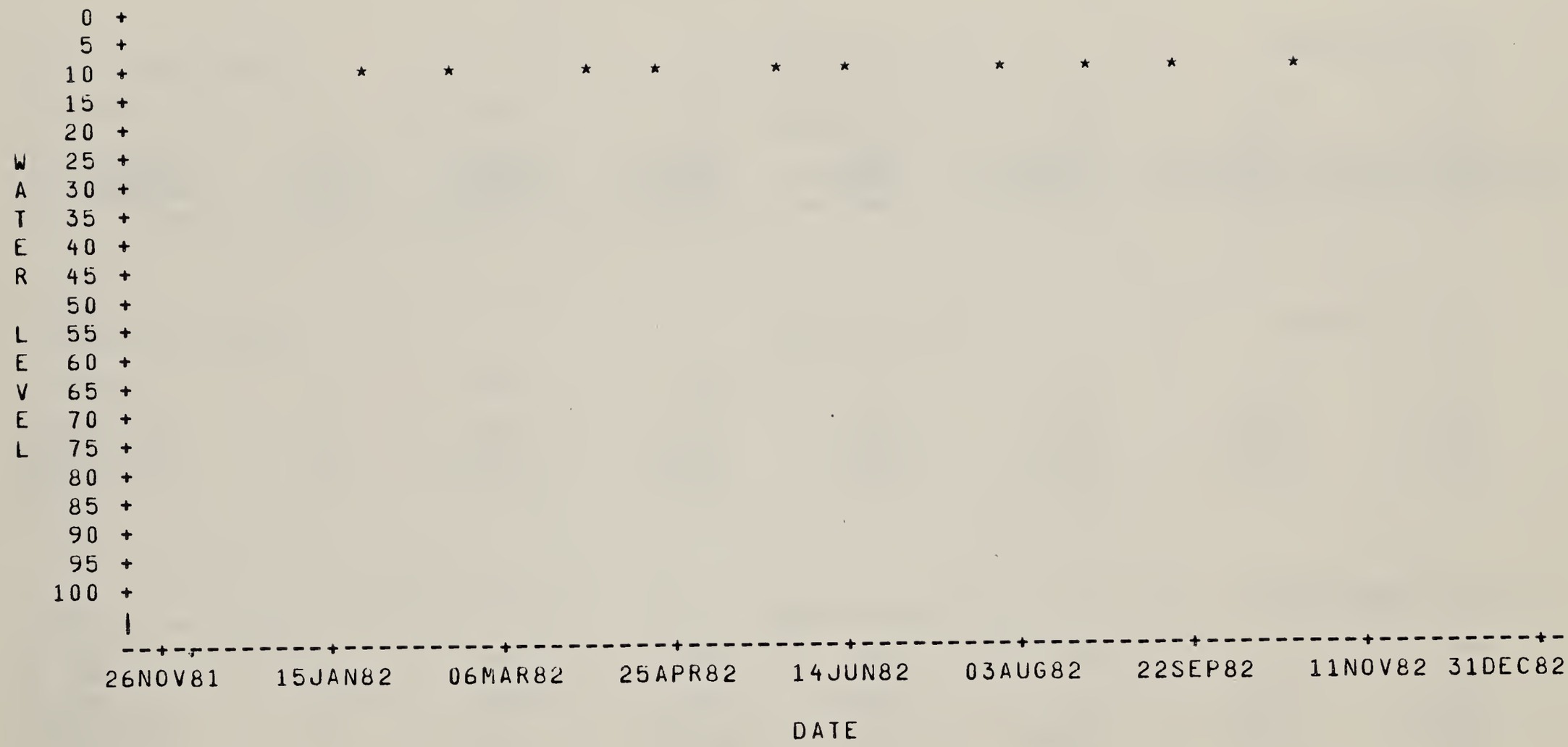


Figure 5-10. Water Levels (feet below surface) at Alluvial Well GS-S24, 1982

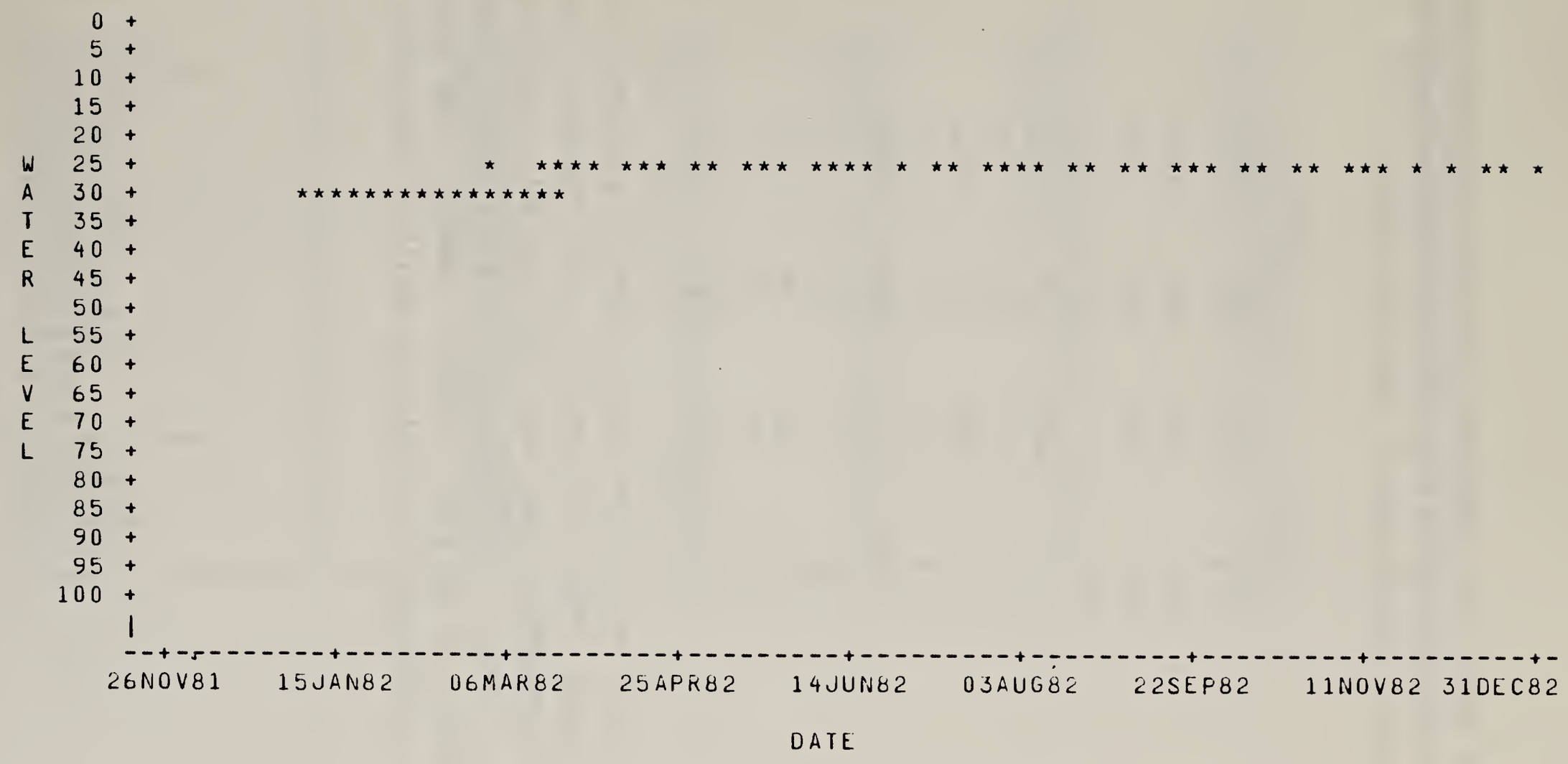


Figure 5-11. Water Levels (feet below surface) at Alluvial Well GS-S27S, 1982

general water quality (TDS, alkalinity, and DOC) at alluvial control wells (Table 5-18) has been fairly stable since the baseline period (1976). The 1982 water quality was comparable to 1981 observations:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.6 | 7.5 | 7.7 | 7.7 |
| ec | 1175 | 1104 | 1250 | 1225 |
| Ca | 93 | 104 | 100 | 115 |
| Mg | 58 | 61 | 63 | 68 |
| K | 1.21 | 1.10 | 1.36 | 1.20 |
| Na | 90 | 89 | 101 | 100 |
| $HCO_3$ | 461 | 450 | 491 | 464 |
| Cl | 13.6 | 17.8 | 16.1 | 34.6 |
| $SO_4$ | 270 | 310 | 312 | 391 |
| F | .29 | .17 | .33 | .38 |
| $NH_3$ | .11 | .19 | .44 | .26 |
| B | .17 | .37 | .25 | .81 |
| DOC | 6.7 | 8.9 | 15 | 20.0 |

Near-field alluvial wells in the MIS Area monitoring program are typically dry. For example, these wells were dry in 1976 and 1980. Because these wells only intermittently contain water, not every well is monitored during each sample period. Consequently, the water quality data for the near-field wells can be quite variable. However, 1982 water quality (Table 5-19) was very similar to 1981 water quality in these wells:

Table 5-18. Summary of Water Quality Data for Alluvial Aquifer Control Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 4 | 7.57 | 0.10 | 7.70 | 7.50 | 7.50 | 7.70 |
| CONDUCTIVITY | 4 | 1175.00 | 64.55 | 1250.00 | 1100.00 | 1100.00 | 1250.00 |
| TOT DIS SOLIDS | 6 | 790.17 | 69.63 | 858.00 | 692.00 | 692.00 | 858.00 |
| ALKALINITY | 6 | 393.67 | 17.95 | 413.00 | 367.00 | 367.00 | 413.00 |
| CALCIUM | 6 | 92.83 | 7.08 | 100.00 | 83.00 | 83.00 | 100.00 |
| MAGNESIUM | 6 | 58.17 | 3.97 | 63.00 | 52.00 | 52.00 | 63.00 |
| POTASSIUM | 6 | 1.21 | 0.09 | 1.36 | 1.11 | 1.11 | 1.36 |
| SODIUM | 6 | 90.17 | 13.04 | 101.00 | 72.00 | 72.00 | 101.00 |
| BICARBONATE | 6 | 461.33 | 21.16 | 491.00 | 432.00 | 432.00 | 491.00 |
| CARBONATE | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 6 | 13.57 | 2.42 | 16.10 | 9.70 | 9.70 | 16.10 |
| NITRATE | 6 | 0.90 | 0.37 | 1.30 | 0.30 | 0.30 | 1.30 |
| SULFATE | 6 | 269.67 | 40.61 | 312.00 | 217.00 | 217.00 | 312.00 |
| FLUORIDE | 6 | 0.29 | 0.04 | 0.33 | 0.20 | 0.20 | 0.33 |
| AMMONIA | 6 | 0.11 | 0.16 | 0.44 | 0.03 | 0.03 | 0.44 |
| PHOSPHATE | 6 | 0.08 | 0.04 | 0.15 | 0.03 | 0.03 | 0.15 |
| BORON | 6 | 0.17 | 0.07 | 0.25 | 0.04 | 0.04 | 0.25 |
| SILICA | 6 | 21.83 | 0.75 | 23.00 | 21.00 | 21.00 | 23.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 6 | 6.67 | 4.55 | 15.00 | 2.00 | 2.00 | 15.00 |
| ARSENIC | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 6 | 0.37 | 0.21 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 6 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 6 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |

Table 5-19. Summary of Water Quality Data for Alluvial Aquifer Near-Field Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 5 | 7.60 | 0.21 | 7.90 | 7.40 | 7.40 | 7.90 |
| CONDUCTIVITY | 5 | 1510.00 | 74.16 | 1600.00 | 1400.00 | 1400.00 | 1600.00 |
| TOT DIS SOLIDS | 5 | 1089.40 | 30.59 | 1128.00 | 1055.00 | 1055.00 | 1128.00 |
| ALKALINITY | 6 | 495.67 | 34.98 | 526.00 | 429.00 | 429.00 | 526.00 |
| CALCIUM | 6 | 110.50 | 8.24 | 120.00 | 99.00 | 99.00 | 120.00 |
| MAGNESIUM | 6 | 87.50 | 2.88 | 91.00 | 83.00 | 83.00 | 91.00 |
| POTASSIUM | 6 | 1.98 | 0.32 | 2.50 | 1.64 | 1.64 | 2.50 |
| SODIUM | 6 | 140.00 | 10.95 | 150.00 | 120.00 | 120.00 | 150.00 |
| BICARBONATE | 6 | 581.83 | 41.52 | 617.00 | 503.00 | 503.00 | 617.00 |
| CARBONATE | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 6 | 13.77 | 2.16 | 18.00 | 12.10 | 12.10 | 18.00 |
| NITRATE | 6 | 0.13 | 0.05 | 0.20 | 0.10 | 0.10 | 0.20 |
| SULFATE | 6 | 441.50 | 13.41 | 453.00 | 418.00 | 418.00 | 453.00 |
| FLUORIDE | 6 | 0.34 | 0.15 | 0.62 | 0.20 | 0.20 | 0.62 |
| AMMONIA | 6 | 0.56 | 0.37 | 0.96 | 0.12 | 0.12 | 0.96 |
| PHOSPHATE | 6 | 0.09 | 0.03 | 0.13 | 0.05 | 0.05 | 0.13 |
| BORON | 6 | 0.28 | 0.05 | 0.34 | 0.21 | 0.21 | 0.34 |
| SILICA | 6 | 22.33 | 2.80 | 27.00 | 19.00 | 19.00 | 27.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 6 | 8.17 | 4.40 | 13.00 | 3.00 | 3.00 | 13.00 |
| ARSENIC | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 6 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 6 | 0.43 | 0.16 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 6 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 6 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| CADMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| LITHIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| MANGANESE | 1 | 0.38 | . | 0.38 | 0.38 | 0.38 | 0.38 |
| NICKEL | 1 | 0.05 | . | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 1 | 2.54 | . | 2.54 | 2.54 | 2.54 | 2.54 |
| TITANIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 1 | 10.00 | . | 10.00 | 10.00 | 10.00 | 10.00 |

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.6 | 7.7 | 7.9 | 7.7 |
| ec | 1510 | 1488 | 1600 | 1500 |
| Ca | 111 | 133 | 120 | 160 |
| Mg | 88 | 96 | 91 | 98 |
| K | 1.98 | 1.3 | 2.50 | 1.6 |
| Na | 140 | 135 | 150 | 140 |
| $HCO_3$ | 582 | 606 | 617 | 613 |
| Cl | 13.8 | 14.0 | 18.0 | 14.2 |
| $SO_4$ | 442 | 486 | 453 | 547 |
| F | .34 | .27 | .62 | .34 |
| $NH_3$ | .56 | .19 | .96 | .34 |
| B | .28 | .28 | .34. | 28 |
| DOC | 8.2 | 5.0 | 13.0 | 6.0 |

In a similar manner, the water quality of the far-field alluvial data set (Table 5-20) has been variable in past years due to intermittent dry conditions in many wells. The 1982 observations for far-field wells are similar to 1981 observations:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.5 | 7.4 | 7.7 | 7.7 |
| ec | 1816 | 1892 | 1900 | 1975 |
| Ca | 123 | 133 | 130 | 150 |
| Mg | 114 | 138 | 120 | 160 |
| K | 1.5 | 2.0 | 2.2 | 2.4 |
| Na | 168 | 170 | 170 | 180 |
| $HCO_3$ | 635 | 628 | 644 | 635 |
| Cl | 17.4 | 18.9 | 18.9 | 20.1 |
| $SO_4$ | 586 | 688 | 639 | 746 |
| F | .34 | .18 | .38 | .32 |
| $NH_3$ | .50 | .72 | 1.24 | 1.50 |
| B | .23 | .74 | .33 | 1.90 |
| DOC | 7.3 | 16.0 | 13.0 | 32.0 |

Table 5-20. Summary of Water Quality Data for Alluvial Aquifer Far-Field Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 3 | 7.50 | 0.26 | 7.70 | 7.20 | 7.20 | 7.70 |
| CONDUCTIVITY | 3 | 1816.67 | 104.08 | 1900.00 | 1700.00 | 1700.00 | 1900.00 |
| TOT DIS SOLIDS | 4 | 1358.00 | 99.93 | 1424.00 | 1210.00 | 1210.00 | 1424.00 |
| ALKALINITY | 4 | 540.75 | 12.95 | 554.00 | 524.00 | 524.00 | 554.00 |
| CALCIUM | 4 | 122.50 | 15.00 | 130.00 | 100.00 | 100.00 | 130.00 |
| MAGNESIUM | 4 | 114.25 | 11.50 | 120.00 | 97.00 | 97.00 | 120.00 |
| POTASSIUM | 4 | 1.52 | 0.79 | 2.20 | 0.44 | 0.44 | 2.20 |
| SODIUM | 4 | 167.50 | 5.00 | 170.00 | 160.00 | 160.00 | 170.00 |
| BICARBONATE | 4 | 634.50 | 13.23 | 644.00 | 615.00 | 615.00 | 644.00 |
| CARBONATE | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 4 | 17.37 | 2.33 | 18.90 | 13.90 | 13.90 | 18.90 |
| NITRATE | 4 | 0.82 | 0.51 | 1.30 | 0.10 | 0.10 | 1.30 |
| SULFATE | 4 | 586.00 | 51.53 | 639.00 | 516.00 | 516.00 | 639.00 |
| FLUORIDE | 4 | 0.34 | 0.04 | 0.38 | 0.30 | 0.30 | 0.38 |
| AMMONIA | 4 | 0.50 | 0.55 | 1.24 | 0.07 | 0.07 | 1.24 |
| PHOSPHATE | 4 | 0.11 | 0.13 | 0.30 | 0.01 | 0.01 | 0.30 |
| BORON | 4 | 0.23 | 0.10 | 0.33 | 0.12 | 0.12 | 0.33 |
| SILICA | 4 | 25.00 | 8.68 | 38.00 | 20.00 | 20.00 | 38.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 4 | 7.25 | 4.19 | 13.00 | 3.00 | 3.00 | 13.00 |
| ARSENIC | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 4 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 4 | 0.40 | 0.20 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 4 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 4 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |

The concentrations for most major inorganic constituents in the MIS alluvial wells increase in the downstream direction. Typically maximum concentrations in MIS alluvial wells in 1982 were observed at far-field stations. Potassium, ammonia, boron and DOC concentrations, however, were generally somewhat higher at near-field than at either far-field or control alluvial wells. This increasing trend in the downstream direction is typical for natural systems. No development related effects were indicated.

3. Statistical Analysis - The results of the alluvial aquifer MANOVA for selected water quality constituents indicate, for most major inorganic constituents, significant variability (at the 0.05 level) for the main effects of monitoring area or station type (control, near-field, far-field) and year:

| | Probability > F | | |
|---|---|---|---|
| Parameter | Area | Year | Area x Year |
| TDS | .0001 | .0009 | .0011 |
| Conductivity | .0001 | .0001 | .2435 |
| pH | .0001 | .0001 | .0001 |
| Alkalinity | .0001 | .3800 | .3903 |
| Calcium | .0317 | .0319 | .6238 |
| Magnesium | .0001 | .0131 | .2502 |
| Sodium | .0001 | .0016 | .7462 |
| Fluoride | .5593 | .0001 | .9787 |
| Chloride | .0040 | .0544 | .9509 |
| Bicarbonate | .0001 | .0163 | .2616 |
| Sulfate | .0001 | .0001 | .0124 |

The interaction term (area x year) was significant for TDS, pH, and sulfate. Thus, for most constituents, the spatial pattern of water quality variability has not changed significantly over time.

Examination of the Hotelling-Lawley trace, Pillai's trace, and Wilk's Criterion variance analyses also indicates that area (station type) and year main effects are very significant. The Roy's Maximum Root Criterion was highly significant indicating that some linear combination of the

variables was significantly different in time and space. A Duncan's Multiple Range test was used to examine the nature and significance of differences in means (Appendix 5-1.4):

| Parameter | Area Significantly Different From Near-Field |
|---|---|
| TDS | Control, far-field |
| Conductivity | Control, far-field |
| pH | Control, far-field |
| Alkalinity | Control |
| Calcium | Control, far-field |
| Magnesium | Control, far-field |
| Sodium | Control, far-field |
| Chloride | Neither |
| Bicarbonate | Control |
| Sulfate | Control, far-field |

Typically, the near-field water quality is significantly different from both control and far-field stations, with the highest mean levels observed for far-field stations. For pH and calcium, there was no significant difference between control and far-field station groups.

Analysis of the differences in means over years indicated the following:

| Parameter | Years Significantly Different from 1982 |
|---|---|
| TDS | 1975, 1976, 1978, 1980 |
| Conductivity | 1975, 1979, 1980 |
| pH | 1975, 1976, 1977 |
| Calcium | 1977, 1978 |
| Magnesium | 1975, 1976, 1978, 1980 |
| Sodium | 1977, 1978, 1980 |
| Fluoride | 1977, 1978, 1981 |
| Bicarbonate | 1975, 1976, 1978, 1980 |
| Sulfate | 1975, 1976, 1978, 1980 |

Only those parameters with significant variability for the year main effect

in the MANOVA were considered. The differences in means are as follows:

| Parameter | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|---|
| TDS | 870 | 937 | 1058 | 835 | 1037 | 792 | 1047 | 1053 |
| Conductivity | 1175 | 1311 | 1460 | 1383 | 2007 | 1088 | 1365 | 1475 |
| pH | 6.5 | 6.4 | 6.8 | 7.6 | 7.3 | 7.6 | 7.5 | 7.6 |
| Calcium | 90 | 89 | 64 | 81 | 96 | 95 | 116 | 106 |
| Magnesium | 58 | 65 | 91 | 58 | 73 | 59 | 86 | 84 |
| Sodium | 140 | 146 | 167 | 193 | 143 | 90 | 117 | 131 |
| Fluoride | 0.4 | 0.3 | 0.2 | 0.1 | 0.3 | 0.3 | 0.2 | 0.3 |
| Bicarbonate | 479 | 476 | 538 | 450 | 541 | 464 | 520 | 552 |
| Sulfate | 291 | 345 | 397 | 318 | 420 | 266 | 434 | 421 |

These results show that in general, the 1982 means are not inconsistent with earlier observations, particularly recent years. Most of the observed changes over time, though significant statistically, do not appear to be of great magnitude nor indicative of development-induced impacts on water quality of the alluvial system.

## E. Upper Aquifer

1. Field Data - Field water quality data for upper aquifer wells during 1982 showed few appreciable changes relative to 1981. Water level changes were mostly associated with changes in the dewatering program as discussed in Section 5.1.

In control wells during 1982, the mean conductivity decreased relative to 1981 (1450 vs. 1900 micromhos per cm respectively). The mean pH was somewhat elevated in 1982 (8.1) relative to 1981 (7.6). This increase was related to the 1982 maximum of 9.1 observed at GS-15U.

At near-field wells, the conductivity was essentially unchanged. The 1982 and 1981 means were 1473 and 1462 micromhos per cm. Minimum and maximum conductivities for the two years were also comparable. Upper aquifer pH was unchanged in the near-field wells.

The water level at near-field wells CE-702U was very steady during 1982 (Figure 5-12). Water levels at GS-MDP2CU rose in the spring for reasons which are unclear and again in the fall due to the mine water pump upset (Figure 5-13).

Far-field upper aquifer wells exhibited elevated mean conductivity in 1982 relative to 1981. The means were 1846 and 1438 micromhos per cm for 1982 and 1981 respectively. The increase was mostly due to a single observation of 3250 micromhos per cm at GS-M5U.

As expected, conductivity increased in the down-gradient direction (Table 5-21). This may be biased by the 3250 micromhos per cm observation at GS-M5U in the far-field. Minimum conductivities were generally comparable in control, near-field, and far-field areas. The upper aquifer pH was generally lower in near-field than in either control or far-field areas.

2. Water Quality Analysis - Upper aquifer water quality data are presented in Appendix 5-1.1. Mean and maximum levels of most water quality parameters for upper aquifer control wells in 1982 (Table 5-22) were somewhat lower than 1981 means:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 8.2 | 7.5 | 8.4 | 8.8 |
| ec | 1100 | 1743 | 1200 | 2400 |
| Ca | 93 | 101 | 120 | 140 |
| Mg | 76 | 102 | 108 | 170 |
| K | .63 | .66 | .91 | 1.04 |
| Na | 160 | 206 | 240 | 320 |
| $HCO_3$ | 578 | 597 | 757 | 775 |
| Cl | 11.3 | 10.2 | 12.9 | 21.8 |
| $SO_4$ | 423 | 619 | 653 | 976 |
| F | .30 | .24 | .47 | .92 |
| $NH_3$ | .22 | .82 | .30 | 4.60 |
| B | .27 | .42 | .35 | 2.40 |
| DOC | 4.3 | 9.7 | 7.0 | 37.0 |

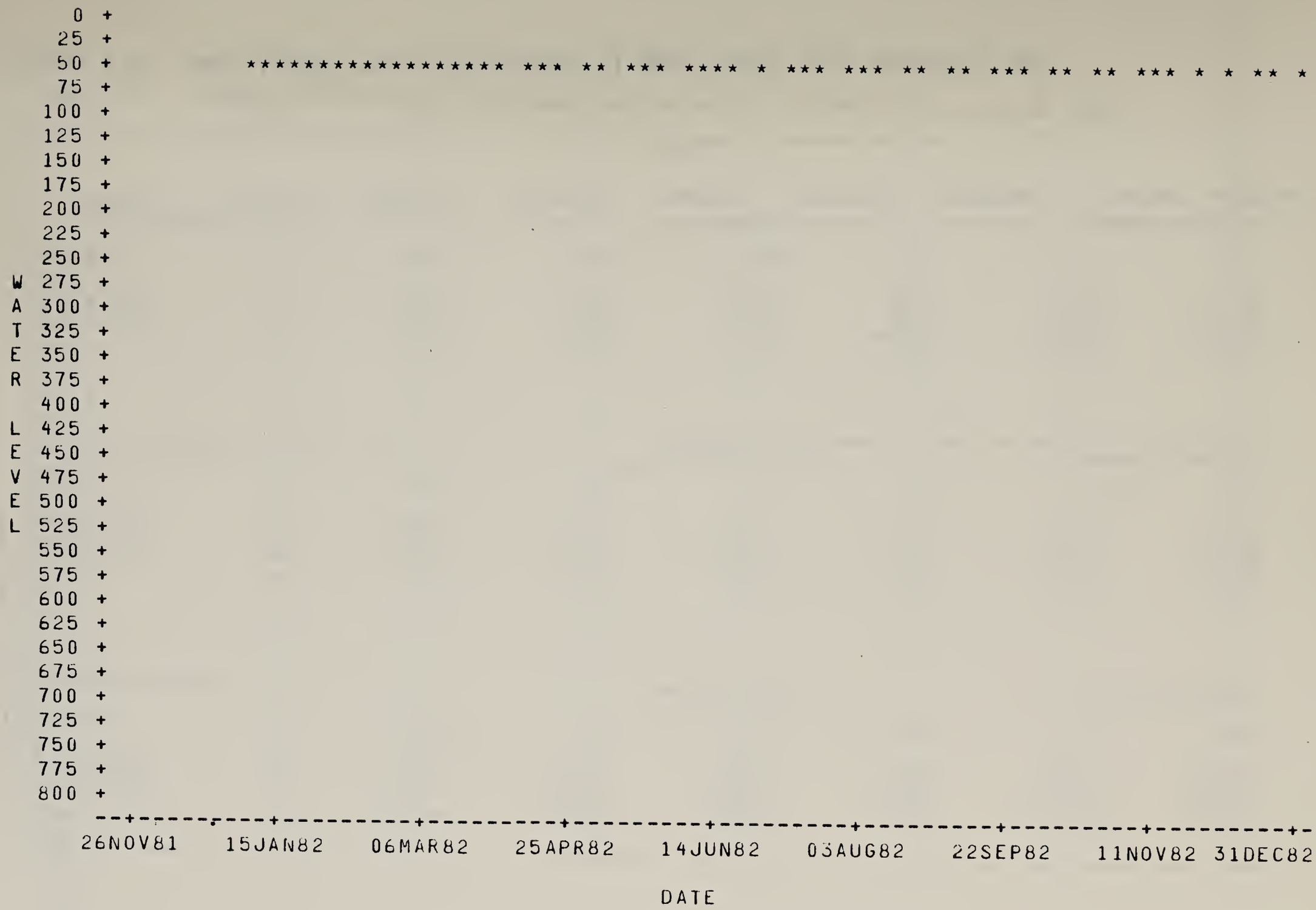


Figure 5-12. Water Levels (feet below surface) at Upper Aquifer Well CE-702U, 1982

Figure 5-13. Water Levels (feet below surface) at Upper Aquifer Well GS-MDP2CU, 1982

Table 5-21. Summary of Field Data from Upper Aquifer Wells, MIS Monitoring Program, 1982.

TYPE=UPPER AQUIFER AREA=CONTROL REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 53 | 348.77 | 103.46 | 409.10 | 50.30 | 58.26 | 407.70 |
| TEMPERATURE | 4 | 12.85 | 1.33 | 14.00 | 11.60 | 11.60 | 14.00 |
| CONDUCTIVITY | 4 | 1450.00 | 443.47 | 2000.00 | 1000.00 | 1000.00 | 2000.00 |
| PH | 4 | 8.10 | 0.88 | 9.10 | 7.00 | 7.00 | 9.10 |

TYPE=UPPER AQUIFER AREA=NEAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 259 | 248.86 | 199.48 | 594.70 | 44.30 | 45.40 | 589.60 |
| TEMPERATURE | 20 | 12.67 | 2.09 | 16.30 | 9.60 | 9.63 | 16.28 |
| CONDUCTIVITY | 20 | 1472.50 | 231.54 | 1900.00 | 1100.00 | 1100.00 | 1895.00 |
| PH | 20 | 7.70 | 0.39 | 8.20 | 6.80 | 6.81 | 8.19 |

TYPE=UPPER AQUIFER AREA=FAR FIELD REPORT YEAR=1982

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| WATER LEVEL | 29 | 56.13 | 87.82 | 233.30 | 11.40 | 11.40 | 233.15 |
| TEMPERATURE | 7 | 10.81 | 2.17 | 13.30 | 7.80 | 7.80 | 13.30 |
| CONDUCTIVITY | 7 | 1846.43 | 888.64 | 3250.00 | 1150.00 | 1150.00 | 3250.00 |
| PH | 7 | 9.00 | 0.74 | 9.70 | 7.60 | 7.60 | 9.70 |

Table 5-22. Summary of Water Quality Data for Upper Aquifer Control Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 2 | 8.15 | 0.35 | 8.40 | 7.90 | 7.90 | 8.40 |
| CONDUCTIVITY | 2 | 1100.00 | 141.42 | 1200.00 | 1000.00 | 1000.00 | 1200.00 |
| TOT DIS SOLIDS | 3 | 1093.33 | 448.74 | 1608.00 | 784.00 | 784.00 | 1608.00 |
| ALKALINITY | 3 | 491.67 | 128.54 | 638.00 | 397.00 | 397.00 | 638.00 |
| CALCIUM | 3 | 93.33 | 25.17 | 120.00 | 70.00 | 70.00 | 120.00 |
| MAGNESIUM | 3 | 76.00 | 27.71 | 108.00 | 60.00 | 60.00 | 108.00 |
| POTASSIUM | 3 | 0.63 | 0.26 | 0.91 | 0.40 | 0.40 | 0.91 |
| SODIUM | 3 | 160.33 | 71.70 | 240.00 | 101.00 | 101.00 | 240.00 |
| BICARBONATE | 3 | 578.33 | 157.24 | 757.00 | 461.00 | 461.00 | 757.00 |
| CARBONATE | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 3 | 11.29 | 2.06 | 12.90 | 8.96 | 8.96 | 12.90 |
| NITRATE | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| SULFATE | 3 | 423.33 | 199.23 | 653.00 | 297.00 | 297.00 | 653.00 |
| FLUORIDE | 3 | 0.30 | 0.16 | 0.47 | 0.16 | 0.16 | 0.47 |
| AMMONIA | 3 | 0.22 | 0.09 | 0.30 | 0.13 | 0.13 | 0.30 |
| PHOSPHATE | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BORON | 3 | 0.27 | 0.07 | 0.35 | 0.22 | 0.22 | 0.35 |
| SILICA | 3 | 34.67 | 8.14 | 44.00 | 29.00 | 29.00 | 44.00 |
| IRON | 0 | • | • | • | • | • | • |
| DIS ORG CARBON | 3 | 4.33 | 2.31 | 7.00 | 3.00 | 3.00 | 7.00 |
| ARSENIC | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 3 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 3 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 3 | 0.37 | 0.23 | 0.50 | 0.10 | 0.10 | 0.50 |
| CADMIUM | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 3 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 3 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 3 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 3 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 3 | 0.08 | 0.06 | 0.14 | 0.04 | 0.04 | 0.14 |
| MANGANESE | 3 | 0.20 | 0.16 | 0.36 | 0.05 | 0.05 | 0.36 |
| NICKEL | 3 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 3 | 2.00 | 0.96 | 3.11 | 1.38 | 1.38 | 3.11 |
| TITANIUM | 3 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 3 | 0.03 | 0.01 | 0.04 | 0.02 | 0.02 | 0.04 |
| ZIRCONIUM | 3 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

The general chemical composition of upper aquifer control stations has not changed appreciably since the baseline period.

The mean concentrations of major inorganic ions in 1982 in near-field upper aquifer wells (Table 5-23) were similar to the means observed in 1981, although observed levels for some constituents were somewhat greater in 1982 than in 1981:

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 7.7 | 7.9 | 8.2 | 8.5 |
| ec | 1428 | 1350 | 1800 | 1750 |
| Ca | 66 | 60 | 130 | 120 |
| Mg | 84 | 77 | 120 | 101 |
| K | .49 | .38 | 1.8 | .97 |
| Na | 176 | 174 | 210 | 240 |
| $HCO_3$ | 559 | 526 | 657 | 613 |
| Cl | 10.4 | 11.2 | 17.4 | 16.2 |
| $SO_4$ | 420 | 395 | 647 | 559 |
| F | 1.05 | .53 | 1.97 | 2.48 |
| $NH_3$ | .31 | .46 | .71 | 1.20 |
| B | .25 | .27 | .33 | 1.03 |
| DOC | 7.7 | 6.7 | 17.0 | 13.0 |

The mean concentrations of major ions in far-field upper aquifer wells in 1982 (Table 5-24) were generally similar to those observed in 1981. Although the 1982 mean and maximum conductivity levels were appreciably greater than for 1981, this change is not reflected in the concentrations of major inorganic ions:

Table 5-23. Summary of Water Quality Data for Upper Aquifer Near-Field Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 16 | 7.66 | 0.41 | 8.20 | 6.80 | 6.80 | 8.20 |
| CONDUCTIVITY | 16 | 1428.13 | 214.65 | 1800.00 | 1100.00 | 1100.00 | 1800.00 |
| TOT DIS SOLIDS | 16 | 1079.44 | 166.57 | 1420.00 | 764.00 | 764.00 | 1420.00 |
| ALKALINITY | 16 | 476.69 | 40.04 | 566.00 | 399.00 | 399.00 | 566.00 |
| CALCIUM | 16 | 65.50 | 32.80 | 130.00 | 32.00 | 32.00 | 130.00 |
| MAGNESIUM | 16 | 84.00 | 17.55 | 120.00 | 59.00 | 59.00 | 120.00 |
| POTASSIUM | 16 | 0.49 | 0.36 | 1.80 | 0.26 | 0.26 | 1.80 |
| SODIUM | 16 | 176.25 | 27.05 | 210.00 | 140.00 | 140.00 | 210.00 |
| BICARBONATE | 16 | 559.13 | 47.46 | 657.00 | 464.00 | 464.00 | 657.00 |
| CARBONATE | 16 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHLORIDE | 16 | 10.39 | 2.91 | 17.40 | 5.70 | 5.70 | 17.40 |
| NITRATE | 16 | 0.24 | 0.31 | 1.20 | 0.00 | 0.00 | 1.20 |
| SULFATE | 16 | 420.06 | 123.78 | 647.00 | 238.00 | 238.00 | 647.00 |
| FLUORIDE | 16 | 1.05 | 0.64 | 1.97 | 0.27 | 0.27 | 1.97 |
| AMMONIA | 16 | 0.31 | 0.16 | 0.71 | 0.07 | 0.07 | 0.71 |
| PHOSPHATE | 16 | 0.06 | 0.08 | 0.25 | 0.01 | 0.01 | 0.25 |
| BORON | 16 | 0.25 | 0.04 | 0.33 | 0.19 | 0.19 | 0.33 |
| SILICA | 16 | 26.75 | 4.86 | 34.00 | 20.00 | 20.00 | 34.00 |
| IRON | 0 | • | • | • | • | • | • |
| DIS ORG CARBON | 16 | 7.69 | 4.59 | 17.00 | 2.00 | 2.00 | 17.00 |
| ARSENIC | 16 | 0.01 | 0.00 | 0.02 | 0.01 | 0.01 | 0.02 |
| SELENIUM | 16 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 16 | 0.40 | 0.18 | 0.50 | 0.10 | 0.10 | 0.50 |
| MOLYBDENUM | 16 | 0.11 | 0.03 | 0.20 | 0.10 | 0.10 | 0.20 |
| MERCURY | 16 | 0.32 | 0.07 | 0.50 | 0.30 | 0.30 | 0.50 |
| ALUMINUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 2 | 0.15 | 0.07 | 0.20 | 0.10 | 0.10 | 0.20 |
| CADMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 2 | 0.09 | 0.05 | 0.13 | 0.06 | 0.06 | 0.13 |
| MANGANESE | 2 | 0.03 | 0.03 | 0.05 | 0.01 | 0.01 | 0.05 |
| NICKEL | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 2 | 4.48 | 2.29 | 6.10 | 2.86 | 2.86 | 6.10 |
| TITANIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 2 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

Table 5-24. Summary of Water Quality Data for Upper Aquifer Far-Field Wells, MIS Monitoring Program, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 2 | 8.30 | 0.99 | 9.00 | 7.60 | 7.60 | 9.00 |
| CONDUCTIVITY | 2 | 2375.00 | 1237.44 | 3250.00 | 1500.00 | 1500.00 | 3250.00 |
| TOT DIS SOLIDS | 2 | 1033.00 | 91.92 | 1098.00 | 968.00 | 968.00 | 1098.00 |
| ALKALINITY | 2 | 521.00 | 74.95 | 574.00 | 468.00 | 468.00 | 574.00 |
| CALCIUM | 2 | 3.75 | 0.07 | 3.80 | 3.70 | 3.70 | 3.80 |
| MAGNESIUM | 2 | 78.00 | 45.25 | 110.00 | 46.00 | 46.00 | 110.00 |
| POTASSIUM | 2 | 1.77 | 0.75 | 2.30 | 1.24 | 1.24 | 2.30 |
| SODIUM | 2 | 245.00 | 63.64 | 290.00 | 200.00 | 200.00 | 290.00 |
| BICARBONATE | 2 | 328.00 | 22.63 | 344.00 | 312.00 | 312.00 | 344.00 |
| CARBONATE | 2 | 14.20 | 5.52 | 18.10 | 10.30 | 10.30 | 18.10 |
| CHLORIDE | 2 | 15.55 | 0.21 | 15.70 | 15.40 | 15.40 | 15.70 |
| NITRATE | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| SULFATE | 2 | 494.00 | 24.04 | 511.00 | 477.00 | 477.00 | 511.00 |
| FLUORIDE | 2 | 0.88 | 0.87 | 1.50 | 0.27 | 0.27 | 1.50 |
| AMMONIA | 2 | 2.50 | 1.92 | 3.86 | 1.15 | 1.15 | 3.86 |
| PHOSPHATE | 2 | 0.07 | 0.03 | 0.09 | 0.05 | 0.05 | 0.09 |
| BORON | 2 | 0.22 | 0.03 | 0.24 | 0.20 | 0.20 | 0.24 |
| SILICA | 2 | 2.50 | 0.71 | 3.00 | 2.00 | 2.00 | 3.00 |
| IRON | 0 | • | • | • | • | • | • |
| DIS ORG CARBON | 2 | 7.00 | 4.24 | 10.00 | 4.00 | 4.00 | 10.00 |
| ARSENIC | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 2 | 0.30 | 0.00 | 0.30 | 0.30 | 0.30 | 0.30 |
| ALUMINUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BARIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| BERYLLIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BISMUTH | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| BROMIDE | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| CADMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| CHROMIUM | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| COPPER | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| GALLIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| GERMANIUM | 2 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 |
| LEAD | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| LITHIUM | 2 | 0.08 | 0.01 | 0.09 | 0.08 | 0.08 | 0.09 |
| MANGANESE | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| NICKEL | 2 | 0.05 | 0.00 | 0.05 | 0.05 | 0.05 | 0.05 |
| STRONTIUM | 2 | 1.12 | 1.45 | 2.15 | 0.10 | 0.10 | 2.15 |
| TITANIUM | 2 | 0.50 | 0.00 | 0.50 | 0.50 | 0.50 | 0.50 |
| ZINC | 2 | 0.01 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 |
| ZIRCONIUM | 2 | 10.00 | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |

| | Mean | | Maximum | |
|---|---|---|---|---|
| | 1982 | 1981 | 1982 | 1981 |
| pH | 8.3 | 9.5 | 9.0 | 9.8 |
| ec | 2375 | 1391 | 3250 | 1575 |
| Ca | 3.8 | 4.7 | 3.8 | 5.8 |
| Mg | 78 | 76.6 | 110 | 120 |
| K | 1.8 | 3.05 | 2.3 | 6.80 |
| Na | 245 | 234 | 290 | 270 |
| $HCO_3$ | 328 | 336 | 344 | 464 |
| Cl | 15.6 | 16.0 | 15.7 | 25.2 |
| $SO_4$ | 494 | 477 | 511 | 660 |
| F | .88 | .44 | 1.50 | 1.56 |
| $NH_3$ | 2.50 | 1.12 | 3.86 | 2.78 |
| B | .22 | .23 | .24 | .68 |
| DOC | 7.0 | 6.7 | 10.0 | 12.0 |

In the upper aquifer wells monitored in 1982 for the MIS Area hydrology monitoring program, the mean salinity (TDS) generally decreased in the downgradient direction (from control to near-field to far-field). This trend was mostly attributable to decreases in calcium, and bicarbonate concentrations:

| Parameter | Control | Near-Field | Far-Field |
|---|---|---|---|
| TDS | 1093 | 1079 | 1033 |
| Calcium | 93 | 66 | 3.8 |
| Bicarbonate | 578 | 559 | 328 |

Sodium, potassium, sulfate and chloride concentrations were generally greater in the far-field than near-field during 1982. No impact-related trends, such as increased concentrations in the near-field wells are apparent from these observations.

3. Statistical Analysis - The results of the MANOVA for selected water quality constituents indicate that, for most major inorganic constituents, significant variability was observed for the main effects,

area (station type) and year. Significant variability over the MIS upper aquifer monitoring areas was observed for all tested constituents except conductivity, alkalinity and sodium:

| | Probability > F | | |
|---|---|---|---|
| Parameter | Area | Year | Area x Year |
| TDS | .0015 | .1961 | .0057 |
| Conductivity | .1547 | .0740 | .0001 |
| pH | .0001 | .0001 | .0001 |
| Alkalinity | .1033 | .0022 | .0001 |
| Calcium | .0001 | .1287 | .0224 |
| Magnesium | .0001 | .0006 | .0009 |
| Sodium | .4574 | .0001 | .0003 |
| Fluoride | .0007 | .0002 | .0001 |
| Chloride | .0140 | .0047 | .0008 |
| Bicarbonate | .0006 | .0001 | .0005 |
| Sulfate | .0001 | .0121 | .0090 |

Significant temporal variability (year main effect) was noted for all constituents except TDS, conductivity, and calcium. All constituents tested showed a significant interaction term (area x year).

Tests on the overall area (station type) effect and overall year main effect were highly significant (PR > F = 0.0001 for all three tests). Roy's Maximum Root Criterion was also highly significant.

A Duncan's Multiple Range Test (Appendix 5-1.4) was used to examine differences in means for constituents for which significant main effect terms were observed from the MANOVA:

| Parameter | Area Significantly Different From Near-Field |
|---|---|
| TDS | Control |
| pH | Control, Far-field |
| Calcium | Control, Far-field |
| Magnesium | Control, Far-field |
| Fluoride | Control, Far-field |
| Chloride | Control |
| Bicarbonate | Far-field |
| Sulfate | Control, Far-field |

All three monitoring areas (station types -- control, near-field, far-field) were significantly different for pH, calcium, and sulfate. Control and far-field station groups were not significantly different for magnesium and fluoride. Means for these station groups area as follows:

| Parameter | Control | Near-Field | Far-Field |
|---|---|---|---|
| TDS | 1380 | 1161 | 1120 |
| pH | 7.2 | 7.6 | 8.3 |
| Calcium | 106 | 59 | 26 |
| Magnesium | 93 | 70 | 93 |
| Fluoride | .6 | 3.1 | 0.7 |
| Chloride | 11 | 16 | 16 |
| Bicarbonate | 629 | 724 | 455 |
| Sulfate | 570 | 338 | 487 |

These data indicate that the mean concentrations for control stations are generally greater than, or comparable to, those for near-field and far-field wells. Exceptions to this generalization are pH and chloride concentrations which generally increase in the down-gradient direction.

The years for which means were significantly different from 1982 are as follows:

| Parameter | Years Significantly Different from 1982 |
|---|---|
| pH | 1975, 1976, 1978 |
| Alkalinity | 1976 |
| Magnesium | none |
| Sodium | 1976 |
| Fluoride | none |
| Chloride | none |
| Bicarbonate | 1976 |
| Sulfate | none |

Differences in means over monitoring years are summarized as follows:

| | Means | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | 1975 | 1976 | 1978 | 1979 | 1980 | 1981 | 1982 |
| pH | 6.7 | 6.8 | 7.6 | 8.0 | 8.0 | 8.1 | 7.8 |
| Alkalinity | 663 | 824 | 373 | 492 | 546 | 491 | 475 |
| Sodium | 323 | 408 | 213 | 217 | 194 | 199 | 178 |
| Bicarbonate | 777 | 942 | 440 | 575 | 582 | 502 | 529 |

These results indicate an increasing trend in pH over time in the upper aquifer, and general decreases in alkalinity and sodium concentrations since the baseline period. Observations of mean concentrations in recent years have been fairly stable and development-related impacts are not evident.

## F. Lower Aquifer

Lower aquifer well GS-15L is included as a control station in the MIS Area hydrology monitoring program (Appendix 5-1.3). The 1982 mean pH and water temperature data were similar to observations for previous years. Lower aquifer (control site) water levels (Figure 5-14) were very similar in 1982 as compared to 1981. The 1982 mean water level was 369.1 while the 1981

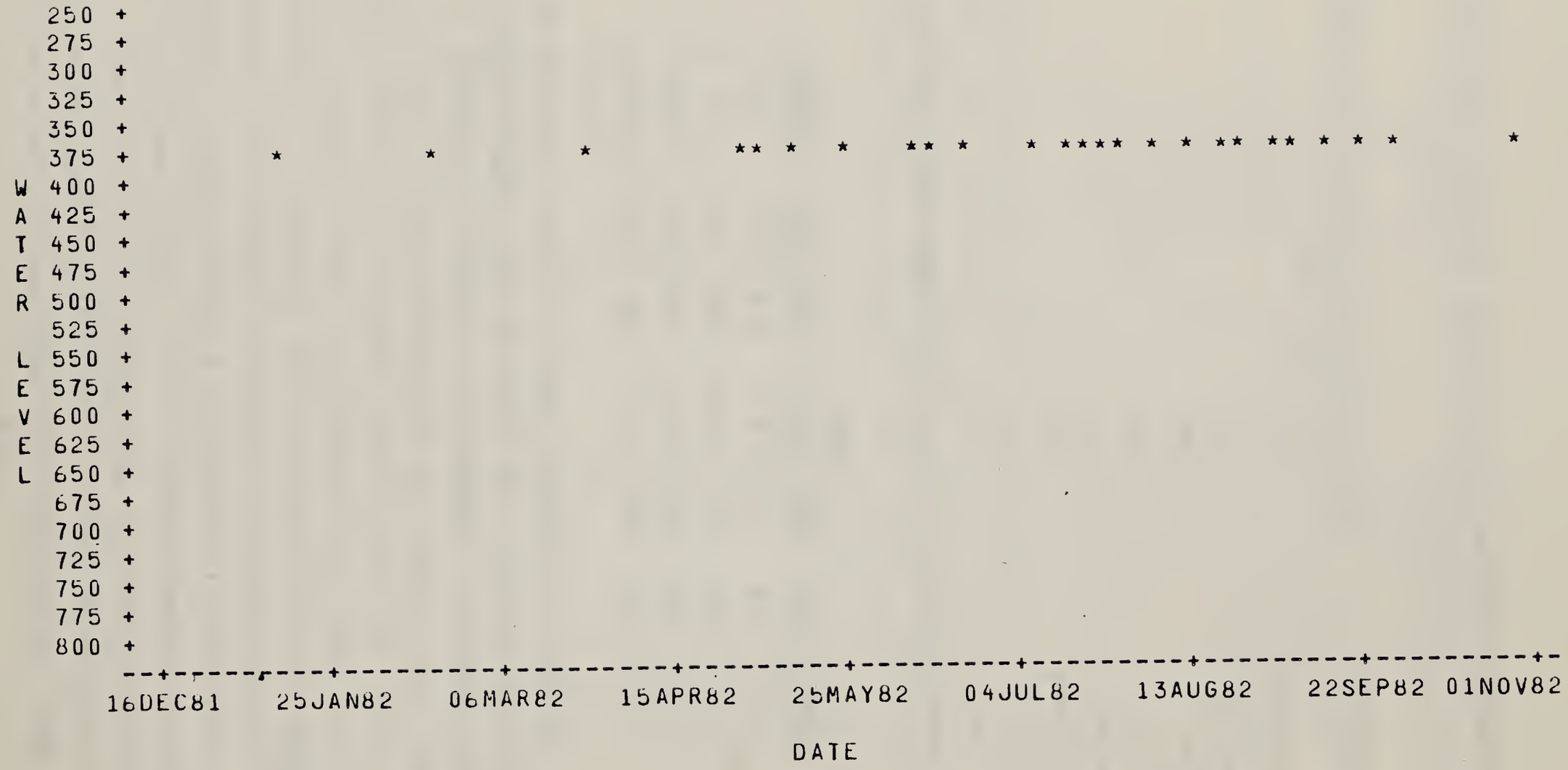


Figure 5-14. Water Levels (feet below surface) at Lower Aquifer Well GS-15L, 1982

mean was 370.6 feet. The annual variation for lower aquifer water level is typically over a 1 to 2 foot range. The 1982 maximum observed conductivity was 4000 micromhos per cm vs. 3750 in 1981.

The single water chemistry sample (Table 5-25) collected during 1982 showed concentrations of most constituents much lower than observed in 1981. Concentrations which exceed 1981 maximum levels were observed only for calcium, carbonate and sulfate ions.

Previous monitoring reports discussed an increasing trend in concentrations of several constituents in the lower aquifer since the baseline period. The trend was related to upper-lower aquifer interconnections during the baseline period. The lower concentrations observed in 1982 relative to recent years may reflect the sampling of a transient element of upper aquifer water.

Table 5-25. Summary of Water Quality Data, Lower Aquifer Well GS-15L, 1982.

| PARAMETER | N | MEAN | STD | MAX | MIN | P5 | P95 |
|---|---|---|---|---|---|---|---|
| PH | 1 | 8.90 | . | 8.90 | 8.90 | 8.90 | 8.90 |
| CONDUCTIVITY | 1 | 1600.00 | . | 1600.00 | 1600.00 | 1600.00 | 1600.00 |
| TOT DIS SOLIDS | 1 | 1030.00 | . | 1030.00 | 1030.00 | 1030.00 | 1030.00 |
| ALKALINITY | 1 | 675.00 | . | 675.00 | 675.00 | 675.00 | 675.00 |
| CALCIUM | 1 | 3.90 | . | 3.90 | 3.90 | 3.90 | 3.90 |
| MAGNESIUM | 1 | 54.00 | . | 54.00 | 54.00 | 54.00 | 54.00 |
| POTASSIUM | 1 | 2.30 | . | 2.30 | 2.30 | 2.30 | 2.30 |
| SODIUM | 1 | 270.00 | . | 270.00 | 270.00 | 270.00 | 270.00 |
| BICARBONATE | 1 | 541.00 | . | 541.00 | 541.00 | 541.00 | 541.00 |
| CARBONATE | 1 | 12.10 | . | 12.10 | 12.10 | 12.10 | 12.10 |
| CHLORIDE | 1 | 19.90 | . | 19.90 | 19.90 | 19.90 | 19.90 |
| NITRATE | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| SULFATE | 1 | 342.00 | . | 342.00 | 342.00 | 342.00 | 342.00 |
| FLUORIDE | 1 | 9.03 | . | 9.03 | 9.03 | 9.03 | 9.03 |
| AMMONIA | 1 | 0.41 | . | 0.41 | 0.41 | 0.41 | 0.41 |
| PHOSPHATE | 1 | 0.02 | . | 0.02 | 0.02 | 0.02 | 0.02 |
| BORON | 1 | 0.46 | . | 0.46 | 0.46 | 0.46 | 0.46 |
| SILICA | 1 | 3.00 | . | 3.00 | 3.00 | 3.00 | 3.00 |
| IRON | 0 | . | . | . | . | . | . |
| DIS ORG CARBON | 1 | 3.00 | . | 3.00 | 3.00 | 3.00 | 3.00 |
| ARSENIC | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| SELENIUM | 1 | 0.01 | . | 0.01 | 0.01 | 0.01 | 0.01 |
| VANADIUM | 1 | 0.50 | . | 0.50 | 0.50 | 0.50 | 0.50 |
| MOLYBDENUM | 1 | 0.10 | . | 0.10 | 0.10 | 0.10 | 0.10 |
| MERCURY | 1 | 0.30 | . | 0.30 | 0.30 | 0.30 | 0.30 |

## 5.3 SUMMARY

The hydrology monitoring program collects information for several needs:

- Stipulations of the lease and conditions of approval from the OSO
- Engineering design input for mine and water handling systems
- Evaluation of the need for environmental mitigative measures
- Permit requirements

The program includes monitoring at numerous installations, including stream gaging stations, springs and seeps, alluvial and deep aquifer wells, surface impoundments, surface discharges, and reinjection system. The natural hydrologic and hydrogeologic environment as well as facilities associated with tract development have been monitored.

During 1982, the hydrology monitoring program was modified to focus on two major development activities on Tract C-a:

- Dewatering/Reinjection/Discharge Program
- MIS Modular Development Area

Hydrology monitoring stations have been classified as follows:

- Type I - control stations not expected to be influenced by a given set of development activities
- Type II - expected to exhibit direct, short-term impacts, should impacts result from development; such stations are located generally downgradient in near-field area relative to development

- Type III - expected to exhibit indirect or long-term impacts; should impacts result from development; such stations are located downgradient from development in far-field areas.

Grouping stations allows for spatial as well as temporal comparison of water quality and physical parameters. Thus "pre and post" development levels and the "control vs potentially affected" areas can be compared.

## A. Dewatering/Reinjection/Discharge Program

During 1982, the dewatering operation was accomplished using mine sumps; dewatering wells were not operated. This resulted in only minor modification of the cone of depression. The 1982 cone of depression exhibited a diminishing of the -200 foot contour relative to 1981, while the -100 foot contour was essentially unchanged. The area of the -60 and -20 foot contours also decreased somewhat during 1982.

Dewatering flows were all reinjected or consumed during 1982 except in March and September when a reinjection line break necessitated the rerouting of mine water to the discharge flume. Flows up to 144 gallons per minute were released in March and up to 404 gallons per minute were released in September. Total surface discharge was less than 2 acre-feet in March and less than 3 acre-feet in September.

As would be expected, water quality in the Jeffrey Pond, which receives mine water, and that observed in the composite reinjection water were similar during 1982. The conductivity of composite reinjection water as measured in lab analyses was in the 1300 to 1600 micromhos per cm range during 1982 with a slight minimum in July, due mostly to small changes in magnesium and bicarbonate concentrations. Of the eighteen trace elements sampled in October, only Br (0.96 mg/l), Li (0.09 mg/l), Mn (0.01 mg/l) and Sr (7.5 mg/l) were above the detection limits of analysis. Overall, the water quality of mine water was stable thoughout 1982 and comparable to observation of previous years.

Water quality observations in upper aquifer control wells during 1982 were generally similar to 1981 values. Observations included increases in mean and maximum observations for some constituents between 1981 and 1982 (e.g. conductivity, calcium, bicarbonate, sulfate). However, these changes are not great and there were decreases for some constituents.

Water quality observed at upper aquifer near-field wells in 1982 showed somewhat elevated conductivity relative to 1981. However, the concentrations of major ions in near-field wells in 1982 were not appreciably greater than observed in 1981. Mean concentrations of calcium, bicarbonate and fluoride at far-field upper aquifer wells in 1982 were slightly greater than 1981 means. However, the overall water quality at the far-field wells was comparable between the two years.

Most of the trace elements monitored in the upper aquifer were below detection limits during 1982. Typically, of the eighteen trace metals sampled, only Br, Li, Mn, and Sr were measureable.

The MANOVA for selected upper aquifer water quality parameters indicated significant variability for most constituents (at the .05 significance level) for all parameters except pH, fluoride, chloride, and marginally for bicarbonate) for the area main effect. Significant variability for the year main effect was noted only for pH, magnesium, sodium, and chloride. The interaction term (area x year) was nonsignificant for all of the constituents examined. This indicates a lack of change in the relative water quality at control, near-field, and far-field wells over time, although the variability among station types and years is highly significant for some constituents when just these main effects are considered. This analysis result (including these specific constituents) was also observed for the 1981 analysis.

The MANOVA analyses, and the Duncan's Multiple Range Test results indicate that, although certain constituents vary significantly in time and space, the general pattern of water quality has not changed appreciably over time. Impact-related changes were not apparent from these analyses.

The water levels have been very uniform over the last three years of record for the lower aquifer, indicating an absence of influence from the continuing reinjection operations.

B. MIS Modular Development Area

Monitoring of the MIS Modular Development Area includes sampling of various process ponds, alluvial aquifers and deep aquifers. The focus of this sampling is on water quality.

In the East Pond, the mean values of several parameters (pH, conductivity, sodium, bicarbonate, carbonate, sulfate, fluoride and DOC) increased in 1982 relative to 1981. However, the maximum values observed during the two years were comparable or the 1982 maxima were lower.

Piezometers 1, 2 and 4 were observed to contain water during 1982. However, the water exhibited conductivities in the 1000 to 1100 micromhos per cm range and pH in the 7.7 to 7.8 range. Thus, no leakage is indicated. Similar water has been observed in these piezometers since 1979 and 1980.

During 1982, the mine sump system for collecting mine water and pumping it to the surface was replaced by submersible pumps, and the mine was placed in a "no-access" mode. Water collected at the bottom of MIS Retort 1 is pumped to the surface using a system separate from the mine-water system.

In September-November, a series of mine-water pump failures resulted in partial flooding of the mine and retort. Water quality data collected during this period show that mine water quality was not appreciably impacted by the incident. The mine and retort water pumping systems were again operational (with additional backup capacity) in November. Water levels are being maintained such that the level in the mine is always above that in the retort.

Observations at stream stations were comparable to spatial and temporal patterns observed in earlier years. The 1982 water quality observed at

YBOXFL and YMET3 was very similar and the 1982 data were similar to 1981 observations at these sites. The concentrations of most major inorganic constituents increased appreciably between YMET3 and YSEOFL, located downstream. Most of the increase in dissolved solids is due to sodium and sulfate concentrations, with calcium, magnesium, bicarbonate, and chloride concentrations contributing to a lesser extent. Most of the increased dissolved solids load is probably due to spring discharges just upstream from SEOFL.

MANOVA techniques were used to evaluate the temporal variability (comparison of 1981 and 1982) at these flume stations. The results showed few differences for any of the stations.

A general water balance for Tract C-a was developed using USGS gage station data. As observed in previous years, the tract area is a net producer of water (i.e. more water leaves than flows onto the tract).

The general water quality (TDS, alkalinity, and DOC) at alluvial control wells has been fairly stable since the baseline period (1976). The 1982 water quality was comparable to 1981 observations. The concentrations for most major inorganic constituents in the MIS alluvial wells increase in the downstream direction. Typically maximum concentrations in MIS alluvial wells in 1982 were observed at far-field stations. Potassium, ammonia, boron and DOC concentrations, however, were generally somewhat higher at near-field than at either far-field or control alluvial wells. This increasing trend in the downstream direction is typical for natural systems. No development related effects were indicated.

The results of the alluvial aquifer MANOVA for selected water quality constituents indicate, for most major inorganic constituents, significant variability (at the 0.05 level) for the main effects of monitoring area or station type (control, near-field, far-field) and year. The interaction term (area x year) was significant for TDS, pH, and sulfate. Thus, for most constituents, the spatial pattern of water quality variability has not changed significantly over time.

The Duncan's Multiple Range Test results show that in general, the 1982 means are not inconsistent with earlier alluvial aquifer observations, particularly recent years. Most of the observed changes over time, though significant statistically, do not appear to be of great magnitude nor indicative of development-induced impacts on water quality of the alluvial system.

Mean and maximum levels of most water quality parameters for upper aquifer control wells in 1982 were somewhat lower than 1981 means. The general chemical composition of upper aquifer control stations has not changed appreciably since the baseline period. The mean concentrations of major inorganic ions in 1982 in near-field upper aquifer wells were similar to the means observed in 1981, although observed levels for some constituents were somewhat greater in 1982 than in 1981.

The mean concentrations of major ions in far-field upper aquifer wells in 1982 were generally similar to those observed in 1981. Although the 1982 mean and maximum conductivity levels were appreciably greater than in 1981, this change was not reflected in the concentrations of major inorganic ions.

In the upper aquifer wells monitored in 1982 for the MIS Area hydrology monitoring program, the mean salinity (TDS) generally decreased in the downgradient direction (from control to near-field to far-field). This trend was mostly attributable to decreases in calcium and bicarbonate concentrations. Sodium, potassium, sulfate and chloride concentrations were generally greater in the far-field than near-field during 1982. No impact-related trends, such as increased concentrations in the near-field wells are apparent from these observations.

The results of the MANOVA for selected water quality constituents for the upper aquifer indicate that, for most major inorganic constituents, significant variability was observed for the main effects, area (station type) and year. Significant variability over the MIS upper aquifer monitoring areas was observed for all tested constituents except conductivity, alkalinity and sodium. Significant temporal variability

(year main effect) was noted for all constituents except TDS, conductivity, and calcium. All constituents tested showed a significant interaction term (area x year).

All three monitoring areas (station types -- control, near-field, far-field) were significantly different for pH, calcium, and sulfate. Control and far-field station groups were not significantly different for magnesium and fluoride. The data indicate that the mean concentrations for control stations are generally greater than, or comparable to, those for near-field and far-field wells. Exceptions to this generalization are pH and chloride concentrations which generally increase in the downgradient direction.

The upper aquifer data also show an increasing trend in pH over time in the upper aquifer, and general decreases in alkalinity and sodium concentrations since the baseline period. Observations of mean concentrations in recent years have been fairly stable and development-related impacts are not evident.

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# SECTION 6

# SPECIAL STUDIES
# ECOLOGICAL INTERRELATIONSHIPS

## 6.0 INTRODUCTION

In addition to the monitoring programs which have been reported in the previous sections of this report, RBOSC is conducting special studies in the following areas:

- o Experimental Revegetation
- o Mule Deer Habitat Modification
- o Shrub Growth Enhancement
- o Altering Natural Succession after Fire for Enhanced Deer-Livestock Forage
- o Run-of-Mine Lysimeter
- o Special Meteorological Investigations
- o Comparison of Inhalable and Total Suspended Particulates
- o Yellow Creek Stream Classification
- o Toxicology

The activities during the 1982 reporting year in these areas are included in the Special Studies - Ecological Interrelationships section. With the exception of the toxicology and lysimeter studies, the efforts included in this section are designed to examine means of mitigating development-related impacts by examining the relationships between the components of the ecosystems involved. The end result of these studies will be an increased understanding of the feasibility of modifying one ecosystem component (such as vegetative community physical structure and phytosociology) to produce a desired effect on another ecosystem component (such as wildlife).

The toxicology studies reported in this section are being conducted to characterize the chemical and physical properties of oil shale and related materials, determine their biological activity, and develop an industrial hygiene program to mitigate or prevent worker exposure and environmental hazards at the RBOSC project site. The run-of-mine lysimeter study is designed to examine the leaching behavior of raw oil shale piles in field conditions, to determine the quality of leachate from such piles, and to

compare the quality of such field-generated leachates to that of laboratory-generated leachates.

## 6.1 REVEGETATION

### A. Experimental Revegetation on Surface Disturbed Sites

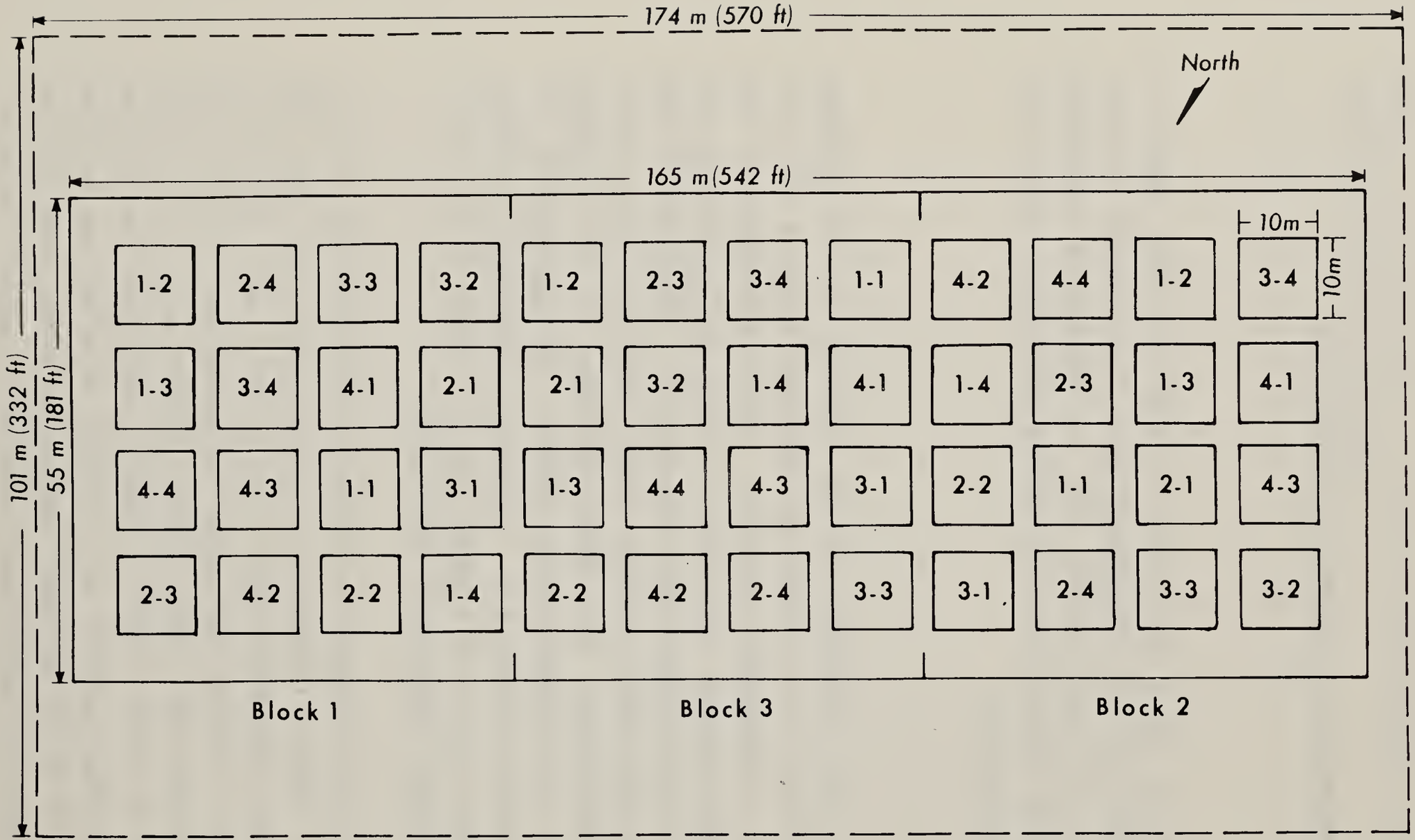
#### 1. Objectives

The development of oil shale facilities on Tract C-a will result in disturbed lands which will be revegetated once disturbance ceases. Experiments were initiated during 1975 to demonstrate reclamation feasibility and species adaptability with varying mulch types, fertilizer applications, and plot aspects.

#### 2. Methods

Experimental plots were constructed at two locations in the southeast corner of Tract C-a; Plot R-1 was located on a northwest exposure and Plot R-2 was located on a southeastern exposure. Surface disturbance at each site included stripping topsoil and subsoil, ripping the underlying rock substrate, and then replacing the subsoil and topsoil. Subsequent to these activities, the sites were seeded, mulched, and/or fertilized using a total of 16 treatment combinations, with three replicates of each treatment applied at each site in a randomized block design. The configuration for Plot R-1 is illustrated in Figure 6-1. Additional information on methods is presented in Section 2.5.3.2 of Progress Report 4 (RBOSP 1975) and in Revegetation Annual Reports (RBOSC 1977, 1978, 1979).

Cover estimates within each treatment combination on Plots R-1 and R-2 were made within four $m^2$ quadrats (numbered 1-4) during 1976, 1977, 1978, 1980 and 1981. Biomass was determined within each of these same quadrats in both 1978 and 1981 by clipping and drying the aboveground standing crop after cover estimates were made. Shrub species, however, were not clipped in 1981. In order to assess cover on quadrats undisturbed by previous clipping, four undisturbed quadrats were randomly selected and sampled during 1982 in each of the 16 treatment combinations within each block on Plots R-1 and R-2. These new quadrats were numbered 5-8 and will serve as




Seeding Rate 18 kg/ha (16 lbs/acre)

| | | | |
|---|---|---|---|
| Mulch Treatments: | 1=No Mulch | Fertilizer Treatments: | 1=No Fertilizer |
| (First Numeral in Treatment Designation) | 2=Hydromulch | (180 kg/ha, 10-5-5) | 2=Fertilizer at Time of Sowing |
| | 3=Straw Mulch Followed by Crimping | (Second Numeral in Treatment Designation) | 3=Fertilizer at Beginning of First Full Growing Season |
| | 4=Straw Mulch With Netting | | 4=Fertilizer at Sowing & Beginning of First Full Growing Season |

Figure 6-1. Treatment Configuration for Experimental Revegetation Plot R1, Tract C-a.

the sample locations where cover will be estimated and aboveground biomass determined during subsequent years.

## 3. Results and Discussion

a. Experimental Revegetation Plot R-1 - Cover estimates for species occurring on Plot R-1 were made July 12-14, 1982. These data are summarized in Table 6-1 and presented in their entirety in Appendix 6-1.1.

Cover for all species over the 16 treatment combinations ranged from 44.8 to 55.1 percent, with a mean of 49.5 percent (Table 6-1). The highest cover value was encountered on plots that were hydromulched and fertilized at the beginning of the first full growing season. The lowest cover was exhibited on those plots with no mulch and fertilizer applied at the beginning of the first full growing season. Mean cover for 1982 was 6.5 percent higher than that recorded for 1981 (RBOSC 1982). This increase may be due, in part, to sampling in undisturbed quadrats during 1982. Cover of herbaceous species on Plot R-1 was greater than the 30 to 41 percent cover recorded with sagebrush communities in the Tract C-a vicinity (see Section 3.1C of this report). Shrub cover on Plot R-1 (4.8 percent) was well below that of surrounding sagebrush communities, where shrub cover averages from 22 to 31 percent (RBOSC 1981, 1982).

Planted grasses accounted for 43 percent of the total cover averaged over all treatment combinations (Table 6-1), which was slightly lower than the 49 and 46 percent recorded for 1981 and 1980 respectively (RBOSC 1981, 1982). Highest cover of planted grasses was shared between plots receiving no mulch and fertilizer at the beginning of the first full growing season, and those with netted straw mulch and fertilizer applications at sowing as well as the beginning of the first full growing season. In the case of the former treatment combination, high cover of planted grasses corresponded to the lowest cover of invaded grasses. This relationship did not hold true for the other treatment combination with high cover of planted grass species. The highest cover of invaded grasses was encountered on plots which received no mulch but were fertilized at the beginning of the first

TABLE 6-1 . MEAN COVER (%) OF PLANTED AND INVADED GRASSES, FORBS, AND SHRUBS FOR EXPERIMENTAL REVEGETATION PLOT R-1 SAMPLED DURING THE CURRENT REPORT YEAR

| TREATMENT COMBINATION | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | SHRUBS PLANTED | SHRUBS INVADED | TOTAL COVER |
|---|---|---|---|---|---|---|---|
| NO MULCH NO FERTILIZER | 18.0 | 4.5 | 17.4 | 3.8 | 3.0 | 0.4 | 47.2 |
| NO MULCH FERTILIZER-SOWING | 19.0 | 4.3 | 23.3 | 1.3 | 6.7 | 0.4 | 55.0 |
| NO MULCH FERTILIZER-1ST GROWING | 27.8 | 0.3 | 9.5 | 2.7 | 4.4 | 0.3 | 44.8 |
| NO MULCH FERTILIZER-SOWING/1ST GROWING | 19.8 | 8.3 | 16.7 | 1.8 | 4.2 | 0.3 | 50.8 |
| HYDROMULCH NO FERTILIZER | 16.8 | 0.1 | 24.9 | 2.6 | 3.0 | 0.4 | 47.7 |
| HYDROMULCH FERTILIZER-SOWING | 18.0 | 4.7 | 18.5 | 4.7 | 5.8 | 1.2 | 52.8 |
| HYDROMULCH FERTILIZER-1ST GROWING | 19.2 | 6.8 | 17.6 | 2.3 | 9.0 | 0.3 | 55.1 |
| HYDROMULCH FERTILIZER-SOWING/1ST GROWING | 14.3 | 7.5 | 23.2 | 3.6 | 4.3 | 0.5 | 53.4 |
| STRAW-CRIMPING NO FERTILIZER | 25.4 | 0.3 | 10.1 | 3.3 | 6.5 | 0.6 | 46.1 |
| STRAW-CRIMPING FERTILIZER-SOWING | 19.1 | 1.3 | 14.2 | 6.7 | 4.3 | 0.2 | 45.6 |
| STRAW-CRIMPING FERTILIZER-1ST GROWING | 15.4 | 7.3 | 18.9 | 9.1 | 2.5 | 0.3 | 53.4 |
| STRAW-CRIMPING FERTILIZER-SOWING/1ST GROWING | 23.7 | 8.0 | 9.3 | 3.8 | 1.8 | . | 46.6 |
| STRAW-NETTING NO FERTILIZER | 25.3 | 0.4 | 15.6 | 1.3 | 3.9 | 0.4 | 47.0 |
| STRAW-NETTING FERTILIZER-SOWING | 25.3 | 6.8 | 10.5 | 1.8 | 3.3 | 0.2 | 47.9 |
| STRAW-NETTING FERTILIZER-1ST GROWING | 26.7 | 1.7 | 13.3 | 2.7 | 1.7 | 0.2 | 46.1 |
| STRAW-NETTING FERTILIZER-SOWING/1ST GROWING | 27.8 | 3.6 | 11.5 | 2.3 | 6.2 | 1.8 | 53.0 |
| MEAN COVER | 21.3 | 4.1 | 15.9 | 3.3 | 4.4 | 0.4 | 49.5 |

full growing season. The dominant planted grasses continued to be the wheatgrass (Agropyron) species. Green needlegrass (Stipa viridula) and Indian ricegrass (Oryzopsis hymenoides), though encountered frequently, contributed lower percentages of cover than did the wheatgrasses. Cheatgrass (Bromus tectorum) and squirreltail (Sitanion hystrix) were the main contributors to cover of invaded grasses, which averaged 4.1 percent over all treatment combinations (Table 6-1).

A statistical comparison of 1982 cover data for planted or invaded grasses between treatment combinations indicated that there were no significant differences for either main (mulch, fertilizer, block) or interaction (block x mulch, etc.) effects (Table 6-2). However, when data for planted and invaded grass cover were compared among years, significant differences were noted (Table 6-3). Duncan's Multiple Range Test results on these main effect differences illustrated an increase in cover of planted grasses through time, which corresponded to varying cover of invaded grass species (Appendix 6-1.2). There was no significant difference in cover of planted grasses between 1982 and 1981, but cover for 1982 was significantly higher than for all sample periods except 1981. These data indicated that the impact resultant from clipping of grasses for biomass determinations was no longer evident after a recovery period of three years. Subsequent to the biomass determinations conducted in 1978, the cover of invaded grasses increased markedly, reaching a level similar to the high cover of invaded grasses noted during the first growing season. However, data collected during 1982 from undisturbed quadrats indicated that cover of invaded grasses was not significantly lower than on areas disturbed by clipping. If clipping aboveground biomass can be assumed to simulate heavy grazing toward the end of the growing season once every third year, data from Plot R-1 indicated that grasses have responded favorably. Planted species recovered well with clipping every third year, while cover of invaded species did not seem to be favored by this impact. It should be noted, however, that impacts early in the growing season and/or for extended periods of time during the growing season may have different results. Consequently, grazing of reclaimed areas should be controlled and monitored very closely.

Table 6-2. Results of Three-way ANOVA's Comparing Arcsine Transformed Grass, Forb, and Shrub Cover Estimates for Planted and Invaded Species Among Treatment Combinations During 1982 on Experimental Revegetation Plot R-1, Tract C-a

| Growth Form | Source of Variation: Block F | Block PR>F [1] | Mulch F | Mulch PR>F [1] | Fertilizer F | Fertilizer PR>F [1] | Block x Mulch F | Block x Mulch PR>F [1] | Block x Fertilizer F | Block x Fertilizer PR>F [1] | Mulch x Fertilizer F | Mulch x Fertilizer PR>F [1] | Block x Mulch x Fertilizer F | Block x Mulch x Fertilizer PR>F [1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses Planted | 0.36 | 0.6995 | 0.93 | 0.4286 | 0.27 | 0.8497 | 0.09 | 0.9969 | 0.15 | 0.9882 | 0.19 | 0.9944 | 0.20 | 0.9998 |
| Grasses Invaded | 1.01 | 0.3705 | 0.59 | 0.6283 | 0.35 | 0.7886 | 0.53 | 0.7820 | 0.97 | 0.4566 | 1.01 | 0.4465 | 0.97 | 0.4773 |
| Forbs Planted [3] | 5.52** | 0.0055 | 0.75 | 0.5274 | 0.26 | 0.8558 | 1.00 | 0.4290 | 0.42 | 0.8631 | 0.66 | 0.7426 | 0.45 | 0.9720 |
| Forbs Invaded [3] | 0.44 | 0.6446 | 3.83** | 0.0109 | 1.12 | 0.3414 | 0.28 | 0.9459 | 0.87 | 0.5175 | 1.74 | 0.0819 | 0.64 | 0.8684 |
| Shrubs Planted | 2.31 | 0.1035 | 0.90 | 0.4468 | 0.45 | 0.7201 | 0.44 | 0.8525 | 1.56 | 0.1640 | 1.74 | 0.0881 | 1.13 | 0.3306 |
| Shrubs Invaded [2] | | | | | | | | | | | | | | |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Represents the significance probability ($\alpha$) associated with F.

2/ Insufficient data to produce ANOVA results.

3/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 6-1.2.

Table 6-3. Results of One-way ANOVA Comparing Arcsine Transformed Cover Estimates for Grasses, Forbs, and Shrubs Between 1976, 1977, 1978, 1980, 1981, and 1982 for Experimental Revegetation Plot R-1, Tract C-a[1/]

| Growth Form | Source of Variation Year | |
|---|---|---|
| | F | PR>F [2/] |
| Grasses Planted | 40.54** | 0.0001 |
| Grasses Invaded | 6.48** | 0.0001 |
| Forbs Planted | 57.10** | 0.0001 |
| Forbs Invaded | 39.24** | 0.0001 |
| Shrubs Planted | 10.01** | 0.0001 |
| Shrubs Invaded | 0.78 | 0.5131 |

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 6-1.2.

2/ Represents the significance probability ($\alpha$) associated with F.

A comparison of grass cover among treatment combinations for all years sampled indicated that there were minor variations resulting from both mulch and fertilizer (Table 6-4). These variations were evident only for the main effects as they pertain to planted species. Duncan's Multiple Range Test results for these main effect differences showed that there was no single mulch or fertilizer treatment that was significantly better than another, based on six years of data. Because these differences were not noted when the ANOVA included only 1982 data (Table 6-2), it is reasonable to assume that the benefits imparted by either mulch or fertilizer were most effective during early years, when establishment of planted and/or invaded grasses was either enhanced or inhibited.

Cover of planted forbs (15.9 percent) during 1982 accounted for 32 percent of the mean cover for all treatment combinations (Table 6-1). This represented an increase from the 24 percent recorded for 1980 and 1981 (RBOSC 1981, 1982). The increase may be related to the new quadrats established in 1982. Cover of planted forbs ranged from 9.3 percent on plots with crimped straw mulch, and fertilized both at sowing and at the beginning of the first growing season, to 24.9 percent on plots which were hydromulched but received no fertilizer (Table 6-1). The most prevalent planted forb species encountered on Plot R-1 continued to be Lewis flax (Linum lewisii), yellow sweetclover (Melilotus officinalis var Madrid) and cicer milkvetch (Astragalus cicer var Lutana). A portion of the cover attributed to Cicer milkvetch may be Utah sweetvetch (Hedysarum utahensis) because, without fruits, the two species are difficult to distinguish. Cover of invaded forb species averaged 3.3 percent over all treatment combinations, with the range being from 1.3 to 9.1 percent. The lowest cover of invaded forb species was shared between plots receiving no mulch and fertilizer at sowing, and those with netted straw mulch and no fertilizer. Plots which received crimped straw mulch and fertilizer at the beginning of the first growing season exhibited the highest cover of invaded forb species. Species richness for invaded species was generally greater than for planted species; however, no single invaded forb approached the cover of planted species. Scarlet gilia (Ipomopsis aggregata), Douglas chaenactis (Chaenactis douglasii), cryptantha

Table 6-4. Results of Three-way ANOVA's Comparing Arcine Transformed Grass, Forb, and Shrub Cover Estimates for Planted and Invaded Species Among Treatment Combinations For All Sample Periods (1977, 1978, 1980, 1981, and 1982) on Experimental Revegetation Plot R-1, Tract C-a

| Growth Form | Source of Variation | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Block | | Mulch | | Fertilizer | | Block x Mulch | | Block x Fertilizer | | Mulch x Fertilizer | | Block x Mulch x Fertilizer | |
| | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ |
| Grasses Planted 2/ | 0.60 | 0.5484 | 2.94* | 0.0316 | 3.11* | 0.0254 | 0.24 | 0.9630 | 0.74 | 0.6160 | 0.89 | 0.5381 | 0.59 | 0.9055 |
| Grasses Invaded | 0.49 | 0.6105 | 0.67 | 0.5717 | 1.86 | 0.1345 | 2.01 | 0.0640 | 1.73 | 0.1139 | 1.39 | 0.1929 | 1.43 | 0.1212 |
| Forbs Planted 2/ | 5.24** | 0.0054 | 4.91** | 0.0024 | 2.34 | 0.0710 | 1.13 | 0.3438 | 0.80 | 0.5681 | 1.42 | 0.1743 | 0.89 | 0.5889 |
| Forbs Invaded | 1.08 | 0.3408 | 2.44 | 0.0622 | 1.58 | 0.1909 | 0.38 | 0.8940 | 1.03 | 0.4023 | 0.91 | 0.5203 | 0.79 | 0.7114 |
| Shrubs Planted 2/ | 0.19 | 0.8267 | 19.36** | 0.0001 | 1.44 | 0.2279 | 0.53 | 0.7836 | 3.90** | 0.0008 | 2.28** | 0.0159 | 1.13 | 0.3158 |
| Shrubs Invaded 2/ | 1.12 | 0.3396 | 0.74 | 0.5347 | 3.52* | 0.0264 | 1.74 | 0.1443 | 1.08 | 0.3978 | 1.99 | 0.0757 | 2.25* | 0.0292 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Represents the significance probability ($\alpha$) associated with F.

2/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 6-1.2.

(Cryptantha sericea) and Machaeranthera species were frequent contributors to invaded forb cover.

Results of the three-way ANOVA comparing 1982 forb cover between treatment combinations indicated significant main effect differences among blocks for planted forbs and among mulch treatments for invaded forbs (Table 6-2). Duncan's Multiple Range Test results indicated that cover of planted forbs was significantly greater in Block 2 than in Block 3 (Appendix 6-1.2). Similar variations were noted in 1981 (RBOSC 1982) so it would seem that the differences are actual rather than sampling artifacts associated with the new set of quadrats sampled during 1982. Although these differences in cover appeared to be less pronounced in 1982, the reasons for the variations in cover remain unclear. Variations in the cover of invaded forb species among mulch treatments were not significant during 1981; however, with the newly sampled quadrats, these differences became more evident during 1982. Duncan's Multiple Range Test results (Appendix 6-1.2) indicated that significantly higher cover of invaded forbs could be expected on plots receiving crimped straw mulch than on those with the other three mulch treatments. Plots treated with netted straw mulch exhibited the lowest cover of invaded forbs. These data do not lend confidence to the supposition that invaded forbs were introduced by application of the straw mulch. Although this may indeed be the case during the first year or two after seeding, increased species richness in later years may indicate distribution from local seed sources.

Although not evident in the 1982 data analyzed alone, cover of planted forbs appeared to be influenced by mulch treatments if data from all years were compared by a three-way ANOVA (Table 6-4). In this instance, Duncan's Multiple Range Test results illustrated that forbs were favored by hydromulch over either crimped or netted straw mulch (Appendix 6-1.2). The fact that a similar influence was not illustrated by the 1982 data alone suggests that mulch treatments were most influential during establishment and/or several years after seeding.

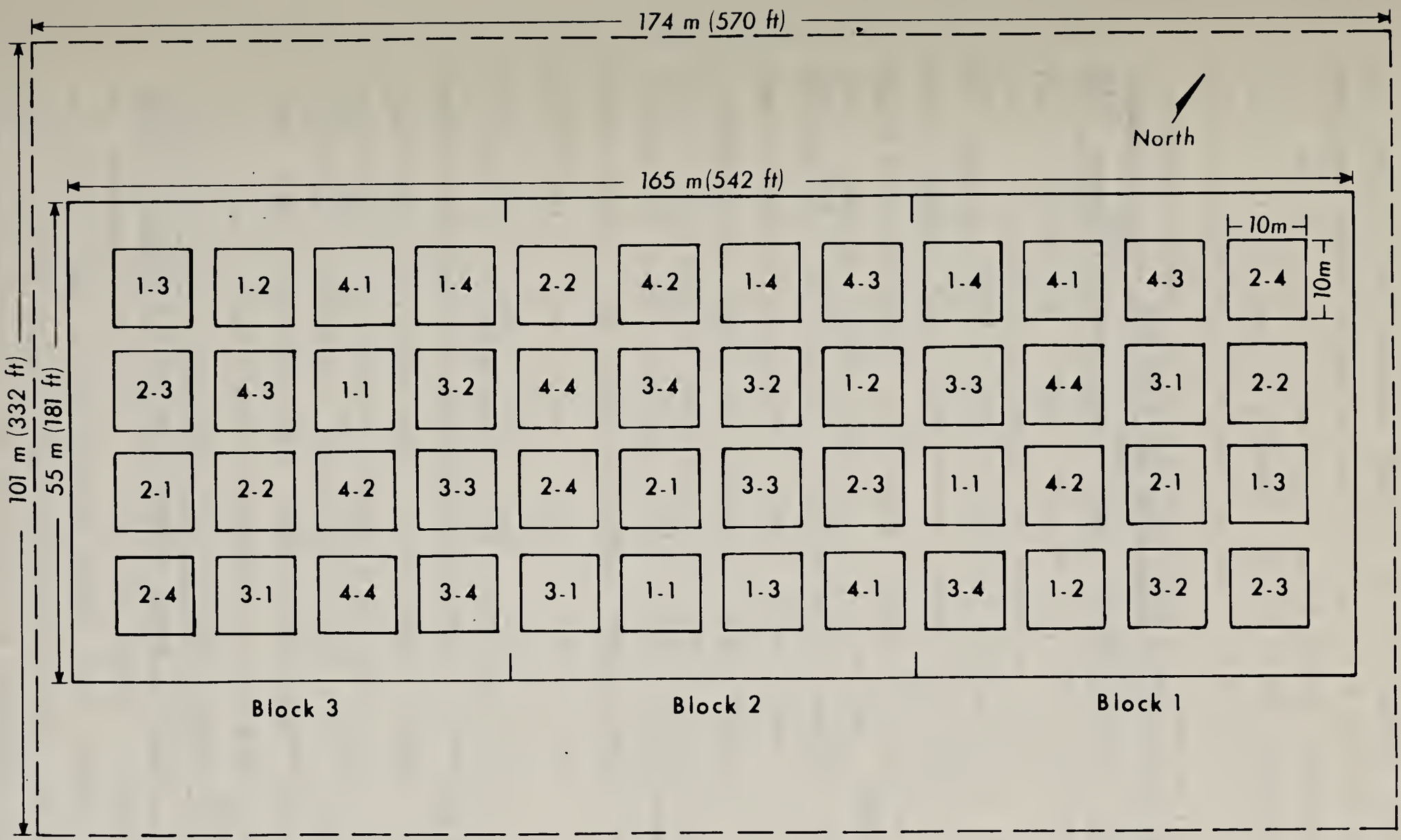
When forb cover was compared among years without regard to treatment combinations, cover of planted forbs was significantly higher in 1982 than for any other sample period (Table 6-3; Appendix 6-1.2). There appeared to be a proportional, inverse relationship between planted and invaded forb cover. Reduced cover of invaded forbs may be related to increased competition resultant from higher cover of both planted grasses and planted forbs, which occurred with increased time since seeding. Because the 1982 data for planted forbs were not grouped with either 1980 or 1981 data (Appendix 6-1.2), it appeared that cover of planted forbs may be influenced by clipping for biomass determinations to greater extent than were the grass species. However, the supposition that this trend will apply to impacts resultant from grazing may not hold true because the proportion of forbs grazed would probably not be as great as that for grasses. Even though grasses tend to be grazed more heavily than forbs, the rhizomatous nature of some grass species, along with intercalary (actively growing primary tissue somewhat removed from the apical meristem) meristematic growth, allow for greater tolerance to grazing.

Shrub cover on newly established quadrats during the 1982 season averaged 4.4 percent for planted species and only 0.4 percent for invaded shrubs (Table 6-1). Total shrub cover accounted for 9.7 percent of all cover on Plot R-1 during 1982, which represented a slight increase relative to 1981. The highest cover of planted shrubs (9.0 percent) was noted on plots which were hydromulched and fertilized at the beginning of the first full growing season, while the lowest cover (1.7 percent) was recorded on sites receiving netted straw mulch and the identical fertilization regime. Cover of invaded shrub species was generally low for all treatment combinations. The highest cover of invaded shrubs (1.8 percent) was found on plots with netted straw mulch, which had been fertilized both at sowing and during the first growing season. Big sagebrush (Artemisia tridentata), winterfat (Ceratoides lanata), and rubber rabbitbrush (Chrysothamnus nauseosus) were the common planted shrubs whereas broom snakeweed (Gutierrezia sarothrae) was the only invaded shrub encountered.

No significant differences in cover of planted shrubs were noted for the 1982 data based on the treatment combinations tested (Table 6-2). However, cover of planted shrubs was significantly higher in 1982 than in any sample period except 1980 (Table 6-3; Appendix 6-1.2). When data from all years were analyzed via a three-way ANOVA, significant differences were noted for certain main and interaction effects (Table 6-4). As noted for both planted grasses and planted forbs, mulch treatments appeared to influence cover of planted shrubs. Results of a Duncan's Multiple Range Test of this main effect difference illustrated that cover of planted shrubs was significantly higher for no mulch and hydromulch treatments than for either straw mulch treatment (Appendix 6-1.2). Invaded shrubs appeared to be influenced by fertilizer treatments. Cover of invaded shrubs was higher on plots fertilized at the time of sowing than on sites receiving no fertilizer or fertilizer at the beginning of the first full growing season (Appendix 6-1.2). Because differences were not evident for 1982 data alone, it is assumed that influences exerted by mulch were effective primarily during establishment and/or early growth of shrubs.

b. Experimental Revegetation Plot R-2 - Cover estimates for species occurring on Plot R-2 were made July 14-19, 1982. The Plot R-2 configuration is illustrated on Figure 6-2. Data collected during 1982 are summarized on Table 6-5 and are presented in their entirety in Appendix 6-1.3.

Cover for all species over the 16 treatment combinations ranged from 30.3 to 46.0 percent, with a mean of 38.6 percent (Table 6-5). The highest cover value was encountered on plots that received straw mulch that was subsequently covered with netting, and which were fertilized both at sowing and at the beginning of the first growing season. The lowest cover was encountered on plots which were not mulched but which received fertilizer at the beginning of the first growing season. Mean cover recorded during 1982 on the newly established quadrats was 8.5 percent higher than that reported for 1981 (RBOSC 1982). Lower cover for 1981 may have been related to the impact of clipping the original sample plots for aboveground biomass determinations during their third year of growth. Unlike Plot R-1 where




Seeding Rate 18 kg/ha (16 lbs/acre)

Mulch Treatments:
(First Numeral in Treatment Designation)

1=No Mulch
2=Hydromulch
3=Straw Mulch Followed by Crimping
4=Straw Mulch With Netting

Fertilizer Treatments:
(180 kg/ha, 10-5-5)
(Second Numeral in Treatment Designation)

1=No Fertilizer
2=Fertilizer at Time of Sowing
3=Fertilizer at Beginning of First Full Growing Season
4=Fertilizer at Sowing & Beginning of First Full Growing Season

Figure 6-2. Treatment Configuration for Experimental Revegetation Plot R2, Tract C-a.

TABLE 6-5 . MEAN COVER (%) OF PLANTED AND INVADED GRASSES, FORBS, AND SHRUBS FOR EXPERIMENTAL REVEGETATION PLOT R-2 SAMPLED DURING THE CURRENT REPORT YEAR

| TREATMENT COMBINATION | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | SHRUBS PLANTED | SHRUBS INVADED | TOTAL COVER |
|---|---|---|---|---|---|---|---|
| NO MULCH NO FERTILIZER | 12.7 | 0.9 | 11.6 | 3.2 | 8.9 | 0.4 | 37.7 |
| NO MULCH FERTILIZER-SOWING | 13.8 | 0.3 | 9.1 | 1.3 | 11.3 | . | 35.7 |
| NO MULCH FERTILIZER-1ST GROWING | 12.3 | 1.2 | 4.8 | 3.0 | 8.9 | 0.1 | 30.3 |
| NO MULCH FERTILIZER-SOWING/1ST GROWING | 11.8 | 2.3 | 5.9 | 1.7 | 14.3 | . | 35.9 |
| HYDROMULCH NO FERTILIZER | 12.4 | 0.3 | 12.6 | 1.7 | 14.1 | 2.1 | 43.2 |
| HYDROMULCH FERTILIZER-SOWING | 12.4 | 1.3 | 6.6 | 2.8 | 12.8 | 0.8 | 36.1 |
| HYDROMULCH FERTILIZER-1ST GROWING | 11.1 | 2.9 | 7.6 | 2.0 | 12.8 | 0.9 | 37.3 |
| HYDROMULCH FERTILIZER-SOWING/1ST GROWING | 11.7 | 4.6 | 11.2 | 2.5 | 7.0 | 0.4 | 37.3 |
| STRAW-CRIMPING NO FERTILIZER | 14.9 | 0.9 | 18.6 | 1.1 | 8.7 | 1.8 | 45.9 |
| STRAW-CRIMPING FERTILIZER-SOWING | 15.0 | 0.8 | 12.3 | 1.8 | 14.2 | 1.6 | 45.7 |
| STRAW-CRIMPING FERTILIZER-1ST GROWING | 11.6 | 0.9 | 5.5 | 1.6 | 9.5 | 1.8 | 30.9 |
| STRAW-CRIMPING FERTILIZER-SOWING/1ST GROWING | 16.8 | 1.4 | 9.8 | 2.4 | 8.3 | 0.2 | 38.8 |
| STRAW-NETTING NO FERTILIZER | 19.9 | 1.2 | 9.0 | 0.7 | 13.9 | 1.2 | 45.8 |
| STRAW-NETTING FERTILIZER-SOWING | 15.8 | 1.7 | 14.8 | 1.3 | 6.2 | 0.5 | 40.1 |
| STRAW-NETTING FERTILIZER-1ST GROWING | 14.5 | 2.6 | 5.0 | 2.2 | 6.4 | 0.2 | 30.8 |
| STRAW-NETTING FERTILIZER-SOWING/1ST GROWING | 16.7 | 2.7 | 13.3 | 1.8 | 10.7 | 0.9 | 46.0 |
| MEAN COVER | 14.0 | 1.6 | 9.8 | 1.9 | 10.5 | 0.8 | 38.6 |

herbaceous cover exceeded that of the surrounding sagebrush communities, herbaceous cover of species on Plot R-2 (27.3 percent) was somewhat lower than the 30 to 41 percent cover noted during the 1982 phytosociological studies. Lower cover is probably related to the southerly exposure of Plot R-2 as compared to the northerly exposure of Plot R-1.

Planted grasses accounted for 36 percent of the total cover averaged over all treatment combinations (Table 6-5), which was slightly lower than the 40 and 41 percent recorded for 1981 and 1980 respectively (RBOSC 1982, 1981). A similar phenomenon was noted on Plot R-1, although cover there was somewhat higher than that for R-2. Highest cover of planted grasses (19.9 percent) was encountered on plots which received no fertilizer, and which were mulched with straw and covered with netting. Cover of invaded grass species ranged from 0.3 to 4.6 percent, with an average of 1.6 percent over all treatment combinations. Invaded grasses accounted for approximately 10 percent of total grass cover. The greatest cover of invaded grass species was found on plots which were hydromulched, and fertilized both at sowing and during the first growing season. Wheatgrass species and Indian ricegrass were the most common planted grasses while squirreltail and needle-and-thread (Stipa comata) were common invaded grasses.

A statistical comparison of 1982 cover data for planted or invaded grasses between treatment combinations indicated that there were no significant differences for either main or interaction effects (Table 6-6). However, when cover of planted and invaded grass species was compared among years, significant differences were noted (Table 6-7). Duncan's Multiple Range Test results on these main effect differences indicated that cover of invaded grass was significantly higher in 1976 than any of the other years (Appendix 6-1.4). Apparently the invaded grasses have been outcompeted by planted species. The relationship among years for planted grass species was somewhat more complex. Cover was similar for 1980 and 1982, with the remaining four sample periods having significantly lower grass cover. Cover for 1981, though lower than that for 1980 and 1982, was higher than cover recorded during 1978, 1977 and 1976 (Appendix 6-1.4).

Table 6-6. Results of Three-way ANOVA's Comparing Arcsine Transformed Grass, Forb, and Shrub Cover Estimates for Planted and Invaded Species Among Treatment Combinations During 1982 on Experimental Revegetation Plot R-2, Tract C-a

| Growth Form | Source of Variation: Block F | Block PR>F 1/ | Mulch F | Mulch PR>F 1/ | Fertilizer F | Fertilizer PR>F 1/ | Block x Mulch F | Block x Mulch PR>F 1/ | Block x Fertilizer F | Block x Fertilizer PR>F 1/ | Mulch x Fertilizer F | Mulch x Fertilizer PR>F 1/ | Block x Mulch x Fertilizer F | Block x Mulch x Fertilizer PR>F 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses Planted | 0.15 | 0.8636 | 1.10 | 0.3520 | 0.64 | 0.5957 | 0.60 | 0.7311 | 0.33 | 0.9197 | 0.30 | 0.9730 | 0.70 | 0.8072 |
| Grasses Invaded | 2.80 | 0.0764 | 0.95 | 0.4306 | 0.29 | 0.8353 | 0.63 | 0.7088 | 0.33 | 0.9161 | 0.24 | 0.9862 | 0.11 | 1.0000 |
| Forbs Planted | 0.65 | 0.5255 | 0.62 | 0.6068 | 1.30 | 0.2841 | 0.67 | 0.6765 | 0.96 | 0.4591 | 0.46 | 0.8956 | 0.48 | 0.9572 |
| Forbs Invaded | 0.02 | 0.9799 | 1.45 | 0.2323 | 0.69 | 0.5642 | 1.63 | 0.1461 | 1.30 | 0.2614 | 1.21 | 0.2954 | 0.85 | 0.6368 |
| Shrubs Planted | 2.05 | 0.1327 | 0.28 | 0.8426 | 0.16 | 0.9221 | 0.97 | 0.4496 | 0.77 | 0.5968 | 1.00 | 0.4427 | 0.62 | 0.8746 |
| Shrubs Invaded 2/ | | | | | | | | | | | | | | |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Represents the significance probability ($\alpha$) associated with F.

2/ Insufficient data to produce ANOVA results.

Table 6-7. Results of One-way ANOVA Comparing Arcsine Transformed Cover Estimates for Grasses, Forbs, and Shrubs Between 1976, 1977, 1978, 1980, 1981, and 1982 for Experimental Revegetation Plot R-2, Tract C-a[1/]

| Growth Form | Source of Variation Year | |
|---|---|---|
| | F | PR>F [2/] |
| Grasses Planted | 45.82** | 0.0001 |
| Grasses Invaded | 20.28** | 0.0001 |
| Forbs Planted | 48.50** | 0.0001 |
| Forbs Invaded | 44.90** | 0.0001 |
| Shrubs Planted | 23.88** | 0.0001 |
| Shrubs Invaded | 1.45 | 0.2452 |

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 6-1.4.

2/ Represents the significance probability ($\alpha$) associated with F.

It is interesting to note the variations in cover between plots established in 1982 and those of previous sample periods. Although the original four plots on each treatment combination had been impacted by clipping in 1978, cover during 1980 was higher than that recorded for 1982. These data seem to indicate that the revegetation plots can tolerate intermittent impacts, which simulate one-time heavy grazing, without serious consequences. The cause for the fluctuation in cover between 1980 and 1981 is unclear.

A comparison of grass cover among treatment combinations for all years sampled indicated that there were significant differences in cover of invaded grasses based on mulch treatment (Table 6-8). Duncan's Multiple Range Test results showed that the two straw mulch treatments were similar. However, the straw mulch held in place by netting resulted in significantly higher cover of invaded grasses than did the hydromulch and no mulch treatments (Appendix 6-1.4).

Cover of planted forbs averaged 9.8 percent for 1982, with a range of from 4.8 to 18.6 percent (Table 6-5). This accounted for 25.3 percent of the total mean cover over all treatment combinations, and represented a slight increase from the 24 and 22 percent values recorded during 1981 and 1980, respectively (RBOSC 1982; 1981). The highest cover of planted forbs was recorded on plots which received straw mulch held in place by crimping and no fertilizer. Cover of invaded forb species ranged from 0.7 to 3.2 percent, with the mean cover over all treatments being 1.9 percent. The highest cover of invaded forbs was found on plots which received neither mulch nor fertilizer. The most prevalent planted forb species encountered on Plot R-2 were Lewis flax and cicer milkvetch. Yellow sweetclover was present occasionally but contributed only slightly to planted forb cover. Douglas chaenactis, cryptantha, Machaeranthera and lobeleaf groundsel (Senecio multilobatus) were common invaded forb species.

Results of the three-way ANOVA comparing 1982 forb cover indicated that there were no significant main or interaction effect differences between treatment combinations (Table 6-6). However, there were differences in forb cover among sample years, as indicated on Table 6-7. Cover of planted

Table 6-8. Results of Three-way ANOVA's Comparing Arcine Transformed Grass, Forb, and Shrub Cover Estimates for Planted and Invaded Species Among Treatment Combinations for All Sample Periods (1977, 1978, 1980, 1981, and 1982) on Experimental Revegetation Plot R-2, Tract C-a

| Growth Form | Source of Variation | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Block | | Mulch | | Fertilizer | | Block x Mulch | | Block x Fertilizer | | Mulch x Fertilizer | | Block x Mulch x Fertilizer | |
| | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ | F | PR>F 1/ |
| Grasses Planted | 2.60 | 0.0749 | 0.82 | 0.4836 | 0.14 | 0.9319 | 0.81 | 0.5659 | 0.88 | 0.5069 | 0.50 | 0.8729 | 0.61 | 0.8948 |
| Grasses Invaded 2/ | 1.91 | 0.1497 | 3.94** | 0.0092 | 0.06 | 0.9750 | 0.81 | 0.5643 | 0.59 | 0.7361 | 0.57 | 0.8196 | 0.30 | 0.9976 |
| Forbs Planted | 0.70 | 0.4969 | 1.13 | 0.3371 | 0.76 | 0.5172 | 2.16* | 0.0451 | 0.58 | 0.7432 | 0.94 | 0.4881 | 1.59 | 0.0563 |
| Forbs Invaded 2/ | 2.55 | 0.0783 | 5.23** | 0.0015 | 2.65* | 0.0470 | 0.74 | 0.6205 | 0.56 | 0.7654 | 1.00 | 0.4367 | 0.24 | 0.9995 |
| Shrubs Planted 2/ | 2.55 | 0.0787 | 9.03** | 0.0001 | 0.62 | 0.6090 | 4.00** | 0.0006 | 1.04 | 0.3978 | 0.96 | 0.4690 | 0.41 | 0.9858 |
| Shrubs Invaded 2/ | 11.91** | 0.0008 | 0.74 | 0.5462 | 0.86 | 0.4846 | 1.00 | 0.4614 | 0.80 | 0.5869 | 0.89 | 0.5522 | 1.37 | 0.2850 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Represents the significance probability ($\alpha$) associated with F.

2/ Duncan's Multiple Range Test results for significant main effects are presented in Appendix 6-1.4.

forbs for 1982 was significantly higher than for any other year sampled (Appendix 6-1.4). Cover for the 1980-1981 period was similar but was significantly higher than that recorded for 1976-1978. The higher forb cover for 1982 may be related to the use of previously unclipped sample plots. If this is the case, it would seem that planted forb species were more susceptible to the impacts resultant from clipping the sample plots than were the planted grass species. Cover of invaded forb species during 1982 was the lowest encountered in the six years of study. Although cover of invaded forbs for 1982 showed no significant difference from 1980 or 1981, cover was significantly lower than that for 1976, 1977 and 1978 (Appendix 6-1.4).

Although the effects of mulch and/or fertilizer were no longer evident in analyses of cover data collected the seventh year after seeding, when data for all years were lumped and analyzed in a three-way ANOVA, significant main and interaction effects were present (Table 6-8). Invaded species had significantly higher cover on plots without mulch than on those hydromulched and/or those receiving straw mulch followed by crimping (Appendix 6-1.4). Cover of invaded forbs on plots which received fertilizer both at sowing as well as during the first growing season was significantly higher than on plots which received no fertilizer. It is reasonable to assume that mulch and fertilizer amendments would impart benefits primarily during establishment and/or the first several years of growth. Because analyses using only the 1982 data did not show significant differences, the main and interaction effect differences noted on Table 6-8 are probably a function of those data collected during the first several years of study. The relative merits of using mulch and/or fertilizer at planting, or shortly thereafter, are questionable based on these results. However, under certain circumstances such as drouth, mulch amendments might be very beneficial.

Shrub cover for planted species on newly established quadrats during the 1982 season averaged 10.5 percent, with the range being from 6.2 to 14.3 percent (Table 6-5). Combined with an average of 0.8 percent cover for invaded shrub species, the total shrub cover accounted for 29 percent of

the total mean cover for all species. This represents an increase from the 20 percent recorded for 1981 (RBOSC 1982). This increase may be due in part to the inherent sampling error associated with newly established quadrats which had not been impacted by clipping during previous years. The highest cover of planted species was recorded on plots which received no mulch but which were fertilized both at sowing and during the first growing season. In addition, a number of other treatment combinations exhibited similarly high cover values (Table 6-5). Rabbitbrush species were the most common planted shrubs encountered, with winterfat and fourwing saltbush (Atriplex canescens) being somewhat less common and contributing lower cover. Broom snakeweed was the only invaded shrub species encountered.

The higher cover of shrubs on Plot R-2 relative to R-1 (11.3 vs. 4.8 percent, respectively) may be related to competition from herbaceous species as well as tolerance to lower available moisture. Decreased available moisture on the southerly exposure of Plot R-2 seems to have resulted in lower cover of herbaceous species, as noted above. If planted shrub species have less competition from herbaceous species and, due to more extensive root systems, are able to tolerate lower moisture conditions, the resultant effects may favor shrub growth.

No significant differences in cover of planted shrubs were noted for the 1982 data based on the 16 treatment combinations (Table 6-6). Data were not sufficient to test cover for invaded species. However, comparisons among years did result in significant differences (Table 6-7). Duncan's Multiple Range Test results show that cover of planted species was similar for 1980-1982 but cover for these three years was significantly higher than that recorded for either 1976, 1977 or 1978 (Appendix 6-1.4). Because the data for 1982 were grouped with 1980 and 1981 data, and were from newly established quadrats which had not been disturbed by clipping, it appears that shrubs have responded reasonably well to the clipping impacts during 1978.

When shrub data for all years were compared, three significant main and

interaction effects were evident (Table 6-8). Duncan's Multiple Range Test results for these main effect differences are presented in Appendix 6-1.4. Cover of planted shrub species was significantly higher on treatments receiving hydromulch and/or no mulch than on either of the straw mulch treatments. It should be noted, however, that this apparent benefit to planted shrub species was no longer evident in either the sixth or seventh years after seeding. The variability in cover of invaded shrub species among blocks may be related to the orientation of Plot R-2 (Figure 6-2). Block 3 is adjacent to a pinyon-juniper stand which is located to the windward side of the plot. Block 1, with its significantly higher cover of invaded shrubs, is surrounded by sagebrush communities on three sides. It is reasonable to assume that lower cover of shrub species within the pinyon-juniper stand, the orientation of R-2 relative to the prevailing winds, and the proximity of Block 1 to shrub seed sources all contribute to the variability in cover of invaded shrub species among the blocks.

c. Precipitation - Rainfall totalled 9.78 inches on Plot R-1 and 10.16 inches on Plot R-2 for the April-October 1982 recording period (Table 6-18, Section 6.1B). These precipitation totals were the highest recorded for seven years of study at the two sites. Mean total precipitation for the April-October period over the previous six years was 7.08 inches at R-1 and 7.23 inches at R-2 (RBOSC 1982). Although precipitation is generally low for the month of June in the vicinity of Tract C-a, during 1982 the period of low precipitation continued into July. The average precipitation during July was approximately one-third of the monthly average based on the six previous years. Because of its southerly exposure, the effective precipitation on Plot R-2 is lower than that of R-1. But, regardless of exposure, the relatively high precipitation amounts in early spring and fall would be expected to favor growth of cool season species.

B. Experimental Revegetation on a Simulated Processed Shale Disposal Site

1. Objectives

During RBOSC's demonstration of surface retorting technology and subsequent commercial operations, processed shale will be produced as a by-product of surface retorting. This material will require surface disposal because not all of the processed shale can be returned as a slurry to in-situ retorts and/or returned to an open pit mine. RBOSC initiated revegetation experiments in 1976 to determine a feasible method of reestablishing a productive, self-sustaining livestock and/or wildlife habitat on processed shale disposal sites.

2. Methods

Revegetation Plot R-3 was established in the fall of 1976, and is located near the southeastern corner of Tract C-a. The plot is situated in an area with a southeast-facing aspect and a slope of approximately 20 percent.

The plot is designed to simulate an artificial soil profile for use in overburden/processed shale disposal piles. This profile, from bottom to top, consists of 0.9 m of segregated sized overburden-like material, 0.3 m of subsoil, and 0.15 m of topsoil. The overburden-like material (0.9 m) is expected to inhibit the capillary migration of soluble, potentially toxic components from the processed shale into the surface plant growth medium. The treatment configuration at Plot R-3 is designed to test the effectiveness of this reconstructed soil profile, as well as various seeding rates and mulch regimes (Figure 6-3). Portions of Plot R-3 underlain by processed shale are considered treatments while those without processed shale serve as controls.

During 1982 cover was assessed within three newly established 1 $m^2$ quadrats randomly selected within each of the 36 treatment plots. These sample quadrats are expected to provide a more accurate representation of cover on Plot R-3 because the new quadrats have not been impacted by clipping for

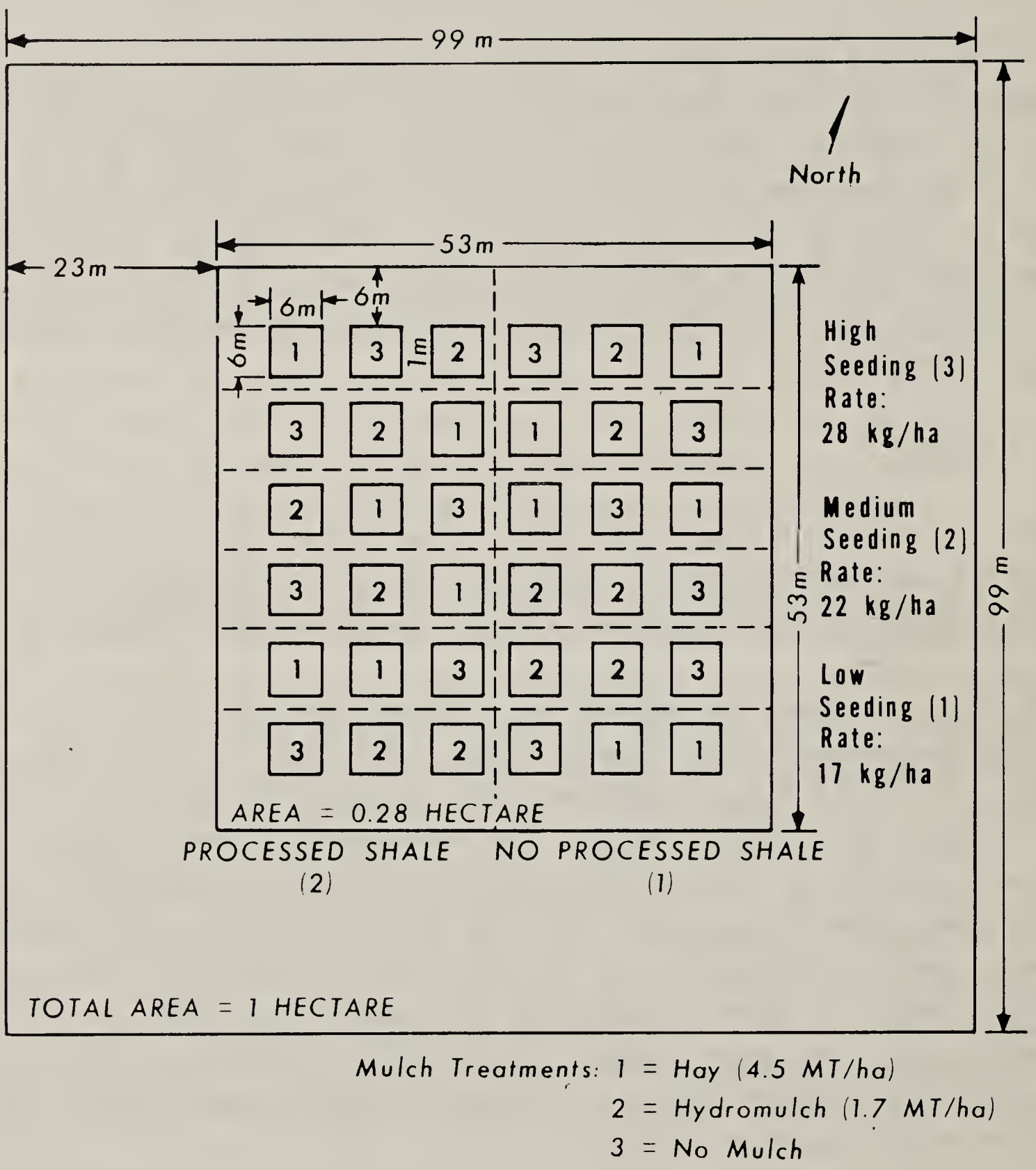



Figure 6-3. Configuration of Experimental Revegetation Plot over 'Tosco II' Processed Shale.

biomass determination. Biomass determinations also were made on the newly established quadrats during the reporting period. However, shrub species were not clipped because of the more severe stress which is imparted to woody as compared to herbaceous species.

Soil samples were collected in 1982 from three depths (0 cm, 1-25 cm, and 26-50 cm) within holes centered above each of 36 plots on R-3. Soil samples were composited by depth for each row in both the treatment and control areas so that, from the 108 individual samples collected, 36 samples were produced for chemical analysis. Soil samples were obtained using a tractor mounted Giddings Soil Auger and were extracted from the same holes into which access tubes for soil moisture determinations were placed. Although soil moisture status was assessed within the reconstructed soil profile during 1982, moisture readings are not expected to be accurate until the void spaces immediately adjacent to the access tubes have filled with soil. Therefore, the 1982 readings and gravimetric moisture determinations are not reported herein but will serve as a baseline for calibration of the neutron probe depth moisture gauge for future readings.

Additional information on experimental revegetation Plot R-3 is available in MDP Monitoring Report 5 (RBOSC 1980) and in Revegetation Annual Reports (RBOSC 1977, 1978, 1979).

## 3. Results and Discussion

a. Cover Data - Cover for grasses, forbs, and shrubs on Plot R-3 was estimated July 26-August 5, 1982. These data are summarized on Table 6-9 and presented in their entirety in Appendix 6-1.5.

Cover for all species averaged 43.5 percent on the control (no processed shale) portion of R-3, with the range being from 38.0 to 53.3 percent. Average cover on the treatment (underlain by processed shale) portion of R-3 was 43.8 percent, with the range being from 28.5 to 64.7 percent. It was interesting to note that the high and low mean cover among treatment

TABLE 6-9. COVERAGE (%) OF PLANTED AND INVADED GRASSES, FORBS, AND SHRUBS FOR EXPERIMENTAL REVEGETATION PLOT R-3 (SUBPLOTS 4, 5, AND 6) DURING THE CURRENT REPORTING YEAR, 1982

| TREATMENTS COMBINATIONS | CONTROL (NO PROCESSED SHALE) | | | | | | | TREATMENT (PROCESSED SHALE) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | SHRUBS PLANTED | SHRUBS INVADED | TOTAL COVER | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | SHRUBS PLANTED | SHRUBS INVADED | TOTAL COVER |
| HAY MULCH LOW SEEDING | 16.3 | 7.8 | 3.3 | 0.7 | 12.5 | 0.2 | 40.8 | 18.5 | 7.8 | 3.5 | 0.7 | 12.2 | 0.7 | 43.3 |
| HYDROMULCH LOW SEEDING | 15.5 | 6.5 | 10.7 | 0.5 | 9.5 | 5.0 | 47.7 | 14.8 | 2.0 | 6.8 | 1.3 | 17.0 | 1.2 | 43.2 |
| NO MULCH LOW SEEDING | 16.5 | 2.3 | 5.3 | 1.3 | 12.2 | 0.3 | 38.0 | 13.2 | 2.3 | 6.0 | 0.8 | 6.0 | 0.2 | 28.5 |
| HAY MULCH MEDIUM SEEDING | 17.5 | 12.3 | 3.8 | 0.3 | 4.8 | . | 38.8 | 16.8 | 5.5 | 4.2 | 0.3 | 15.5 | . | 42.3 |
| HYDROMULCH MEDIUM SEEDING | 21.3 | 2.3 | 7.0 | 0.2 | 17.8 | 4.7 | 53.3 | 19.3 | 4.0 | 15.8 | 0.5 | 23.7 | 1.3 | 64.7 |
| NO MULCH MEDIUM SEEDING | 17.0 | 2.5 | 8.0 | 2.0 | 13.3 | 2.7 | 45.5 | 16.3 | 5.3 | 7.3 | 0.8 | 10.3 | . | 40.2 |
| HAY MULCH HIGH SEEDING | 16.3 | 4.3 | 9.2 | 1.2 | 12.0 | . | 43.0 | 19.8 | 4.3 | 1.7 | 0.8 | 11.8 | 2.2 | 40.7 |
| HYDROMULCH HIGH SEEDING | 19.5 | 1.3 | 8.8 | 0.7 | 9.3 | . | 39.7 | 18.7 | 1.0 | 9.7 | 0.3 | 19.0 | . | 48.7 |
| NO MULCH HIGH SEEDING | 24.5 | 0.8 | 5.7 | 0.5 | 12.8 | 0.2 | 44.5 | 12.8 | 1.3 | 2.8 | 0.7 | 25.2 | . | 42.8 |
| MEAN COVER | 18.3 | 4.5 | 6.9 | 0.8 | 11.6 | 1.4 | 43.5 | 16.7 | 3.7 | 6.4 | 0.7 | 15.6 | 0.6 | 43.8 |

combinations corresponded for the control and treatment portions of the Plot R-3 (Table 6-9). Highest cover was recorded on treatment combinations which were seeded at the medium rate (22 kg/ha) and which were hydromulched. Lowest cover was present on treatment combinations which received no mulch and were seeded at the lowest rate (17 kg/ha). Cover of herbaceous species recorded during 1982 was lower on both treatment and control portions of the study area than that recorded during either 1979, 1980 or 1981 (RBOSC 1980, 1981, 1982). The combined cover of herbaceous species for Plot R-3, averaged over all treatments, illustrates this fact (Table 6-10).

Planted grasses accounted for 42.1 percent of the total mean cover on the control portion of R-3 and 38.1 percent on the treatment side. Cover of invaded grass species, as a proportion of total mean cover, was slightly higher on the control portion than on the treatment side of R-3, 10.3 and 8.4 percent respectively. A visual inspection of Table 6-9 revealed that high and/or low cover of grasses did not necessarily correspond with the treatment combinations which exhibited the highest or lowest mean cover for all growth forms. As reported for 1981 (RBOSC 1982), during 1982 the important planted species throughout Plot R-3 continued to be wheatgrass species and Indian ricegrass while the most prominent invaded species included cheatgrass and crested wheatgrass (Agropyron cristatum) (Appendix 6-1.5).

A statistical comparison of 1982 cover data for all planted and invaded grasses showed that, for the most part, there were no significant differences based on the treatment combinations tested (Table 6-11). However, it was noted that cover of invaded grass species was significantly higher on hay mulched plots than on those areas which received no mulch (Appendix 6-1.6). It is reasonable to assume that the invaded grasses were introduced with the hay mulch and have remained competative with the planted species throughout the six years of growth for Plot R-3.

When cover was considered for individual planted grass species, a significant main effect difference based on seeding rate was evident for wheatgrass species (Table 6-12). Duncan's Multiple Range Test results for

Table 6-10. Comparison of Mean Cover (%) Among Years for All Treatment Combinations on Experimental Revegetation Plot R-3, Tract C-a

| Growth Form | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1977 | 1978 | 1979 plots clipped | 1980 | 1981 | 1982[1/] |
| Grasses Planted | 5.6 | 14.0 | 28.8 | 24.7 | 22.7 | 17.4 |
| Grasses Invaded | 0.8 | 0.5 | 1.5 | 3.4 | 3.0 | 4.1 |
| Forbs Planted | 8.0 | 5.1 | 3.5 | 4.0 | 7.3 | 6.6 |
| Forbs Invaded | 1.2 | 0.6 | 0.9 | 0.4 | 0.3 | 0.8 |
| Shrubs Planted | 4.7 | 7.2 | 16.7 | 4.0 | 4.4 | 13.6 |
| Shrubs Invaded | 0.0 | 0.1 | 0.2 | 0.1 | 0.2 | 1.0 |
| TOTAL | 20.3 | 27.5 | 51.6 | 36.6 | 37.9 | 43.5 |

[1/] Data are based on cover estimates from sample quadrats established in 1982.

Table 6-11. Results of a Three-way ANOVA Comparing Arcsine Transformed Cover Estimates for Planted and Invaded Grass, Forb, and Shrub Species During 1982 on Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation: Substrate F | Substrate PR>F [2/] | Mulch F | Mulch PR>F [2/] | Seeding F | Seeding PR>F [2/] | Substrate x Mulch F | Substrate x Mulch PR>F [2/] | Substrate x Seeding F | Substrate x Seeding PR>F [2/] | Mulch x Seeding F | Mulch x Seeding PR>F [2/] | Substrate x Mulch x Seeding F | Substrate x Mulch x Seeding PR>F [2/] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses Planted | 0.71 | 0.4015 | 0.01 | 0.9857 | 0.48 | 0.6174 | 0.97 | 0.3810 | 0.10 | 0.9037 | 0.24 | 0.9133 | 0.22 | 0.9269 |
| Grasses Invaded | 0.29 | 0.5929 | 3.27* | 0.0457 | 1.14 | 0.3262 | 0.97 | 0.3844 | 0.27 | 0.7621 | 0.27 | 0.8935 | 0.78 | 0.5450 |
| Forbs Planted | 0.04 | 0.8390 | 2.17 | 0.1224 | 0.03 | 0.9693 | 0.21 | 0.8105 | 0.49 | 0.6128 | 0.23 | 0.9179 | 0.66 | 0.6238 |
| Forbs Invaded | 0.23 | 0.6360 | 2.47 | 0.0979 | 0.49 | 0.6186 | 3.34* | 0.0459 | 3.22 | 0.0510 | 0.70 | 0.5942 | 1.15 | 0.3475 |
| Shrubs Planted | 0.99 | 0.3210 | 0.70 | 0.4986 | 0.02 | 0.9808 | 0.33 | 0.7175 | 0.48 | 0.6183 | 0.78 | 0.5418 | 0.50 | 0.7343 |
| Shrubs Invaded [3/] | 0.48 | 0.5077 | 0.85 | 0.4581 | 0.21 | 0.8175 | 0.25 | 0.7837 | 0.13 | 0.8838 | 0.14 | 0.7166 | | |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effect differences are presented in Appendix 6-1.6.

2/ Represents the significance probability ($\alpha$) associated with F.

3/ Missing values result from insufficient data to complete the ANOVA.

Table 6-12. Results of a Three-way ANOVA Comparing Arcsine Transformed Cover Estimates for Planted Species Encountered During 1982 on Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation: Substrate F | Substrate PR>F[2/] | Mulch F | Mulch PR>F[2/] | Seeding F | Seeding PR>F[2/] | Substrate x Mulch F | Substrate x Mulch PR>F[2/] | Substrate x Seeding F | Substrate x Seeding PR>F[2/] | Mulch x Seeding F | Mulch x Seeding PR>F[2/] | Substrate x Mulch x Seeding F | Substrate x Mulch x Seeding PR>F[2/] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses Planted | | | | | | | | | | | | | | |
| Agropyron species | 0.04 | 0.8533 | 0.07 | 0.9359 | 5.31** | 0.0161 | 0.06 | 0.9398 | 0.03 | 0.9672 | 0.06 | 0.9937 | 0.11 | 0.9774 |
| Agropyron trichophorum | 1.01 | 0.3314 | 0.07 | 0.9288 | 20.52** | 0.0001 | 2.59 | 0.1083 | 0.58 | 0.5716 | 0.26 | 0.9008 | 1.52 | 0.2453 |
| Bromus inermis | 0.01 | 0.9181 | 3.00 | 0.0763 | 2.49 | 0.1123 | 0.26 | 0.7759 | 0.24 | 0.7909 | 2.39 | 0.0919 | 0.30 | 0.8765 |
| Oryzopsis hymenoides | 1.76 | 0.2046 | 2.59 | 0.1079 | 2.67 | 0.1017 | 0.58 | 0.5717 | 0.35 | 0.7070 | 1.23 | 0.3415 | 0.59 | 0.6753 |
| Stipa viridula | 0.23 | 0.6410 | 0.52 | 0.6122 | 0.69 | 0.5246 | 1.62 | 0.2467 | 0.73 | 0.4134 | 0.45 | 0.6478 | 0.02 | 0.8797 |
| Forbs Planted | | | | | | | | | | | | | | |
| Astragalus cicer | 0.06 | 0.8068 | 3.05 | 0.0739 | 0.09 | 0.9117 | 0.78 | 0.4751 | 1.44 | 0.2647 | 0.22 | 0.9252 | 0.57 | 0.6882 |
| Linum lewisii[3/] | | | | | | | | | | | | | | |
| Melilotus officinalis | 0.89 | 0.3606 | 2.13 | 0.1539 | 0.70 | 0.5111 | 0.08 | 0.9242 | 2.18 | 0.1481 | 2.20 | 0.1181 | 2.74 | 0.0683 |
| Shrubs Planted | | | | | | | | | | | | | | |
| Atriplex canescens | 3.53 | 0.0849 | 0.55 | 0.5896 | 0.43 | 0.6590 | 1.28 | 0.3122 | 0.58 | 0.5722 | 1.72 | 0.2101 | 1.48 | 0.2703 |
| Chrysothamnus nauseosus | 40.22** | 0.0014 | 28.52** | 0.0018 | 31.19** | 0.0015 | 44.43** | 0.0011 | 0.77 | 0.4210 | 29.32** | 0.0013 | 0.39 | 0.5596 |
| Ceratoides lanata | 0.27 | 0.6132 | 1.38 | 0.2813 | 1.05 | 0.3756 | 0.49 | 0.6250 | 5.54** | 0.0158 | 0.26 | 0.9020 | 1.71 | 0.1993 |
| Purshia tridentata | 0.01 | 0.9436 | 1.17 | 0.3388 | 1.56 | 0.2455 | 0.11 | 0.8964 | 0.45 | 0.6467 | 0.34 | 0.8437 | 0.22 | 0.8832 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effect differences are presented in Appendix 6-1.6.

2/ Represents the significance probability ($\alpha$) associated with F.

3/ Missing values result from insufficient data to complete the ANOVA.

these main effect differences are presented in Appendix 6-1.6. Pubescent wheatgrass (Agropyron trichophorum) exhibited significant differences in cover for each seeding treatment, the higher the seeding rate the higher the resultant cover. Differences for wheatgrass species in general were not so distinct; however, cover was higher within areas seeded at the low rate than in those seeded at the highest rate. The data for pubescent wheatgrass were similar to those noted during 1981, but data for other wheatgrass species were reversed from those recorded for 1981 (RBOSC 1982). It is not clear why the relationship between seeding rate and cover of wheatgrass species would change from year to year, but this phenomenon may be related to impacts resultant from clipping plots for biomass determinations.

Comparison of grass cover among years (Table 6-13) indicated that significant differences exist for both planted and invaded species. Cover of planted grass species was significantly higher in 1979 than any other year (Appendix 6-1.6). Though lower than that for 1979, cover of planted grasses was similar in 1980 and 1981. Cover during 1982 was similar to that recorded in both 1981 and 1978. If cover of grasses had been adversely influenced by clipping of aboveground biomass during 1979, one would have expected the cover estimates determined on newly established plots during 1982 to be higher than those for 1980 and 1981. This is not the case (Table 6-10). An inspection of data for 1982 based on the original sample quadrats showed that cover remained 2 to 4 percent higher than that reported on Table 6-9 for the newly established quadrats. It is possible that cover on the various treatment combinations is variable and that the apparent anomaly in cover data between years results from inherent sampling error related to random plot selection. Cover of invaded grass species during 1982 was similar to that for all other years except 1977, which exhibited the lowest cover (Appendix 6-1.6). The high cover of invaded grasses noted for 1980, the year immediately following clipping, may be related to reduced competition from planted species.

Cover of planted forb species accounted for 15.9 percent of the total mean cover on the control portion of R-3 and 14.6 percent on the treatment side.

Table 6-13. Results of a One-Way ANOVA Comparing Arcsine Transformed Cover Estimates of Planted and Invaded Grasses, Forbs, and Shrubs for 1977, 1978, 1979, 1980, 1981 and 1982 for Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation Year | |
|---|---|---|
| | F | PR>F [2/] |
| Grasses Planted | 31.55** | 0.0001 |
| Grasses Invaded | 5.53** | 0.0001 |
| Forbs Planted | 7.60** | 0.0001 |
| Forbs Invaded | 0.71 | 0.6212 |
| Shrubs Planted | 16.59** | 0.0001 |
| Shrubs Invaded | 2.03 | 0.1277 |

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant effects are presented in Appendix 6-1.6.

2/ Represents the significance probability ($\alpha$) associated with F.

Cover of invaded forb species as a proportion of total mean cover was slightly higher on the control portion than on the treatment side of R-3, 1.8 and 1.6 percent respectively. High and low forb cover among treatment combinations did not correspond to those treatments which exhibited highest or lowest cover averaged for all growth forms (Table 6-9). Nevertheless, plots which received hydromulch tended to have slightly higher cover of planted forb species than the hay or no mulch treatments. Although cicer milkvetch contributed the largest proportion of planted forb cover, yellow sweetclover, and to a lesser extent Lewis flax, were present in many plots. Among the invaded species, Machaeranthera, Cryptantha and twinpod (Physaria floribunda) were the more common forbs encountered (Appendix 6-1.5).

A statistical comparison of 1982 cover data for all planted and invaded grasses showed no main effect and only one significant interaction effect difference among the various treatment combinations (Table 6-11). When considered individually, a similar phenomenon was evident (Table 6-12). Of the two planted forb species with a sufficient number of occurrences to show results in the three-way ANOVA, there were no significant main or interaction effects among substrate, mulch or seeding treatments.

When cover data for planted and invaded forb species were compared among years, significant differences were evident for planted species (Table 6-13). Duncan's Multiple Range Test results illustrate the complex relationship among years (Appendix 6-1.6). Cover was the highest in 1981 but cover for 1982, though lower, was not significantly different. Forb cover for 1980 was lower than that for 1982 but not significantly different. Low cover of forbs in 1979 corresponded to high cover of planted grasses. It is reasonable to assume that competition from the grasses inhibited the forbs. Higher cover of forbs in the two years after clipping the quadrats for biomass determinations in 1979 could be related to decreased competition from grasses (Table 6-10). The relatively high cover of planted forbs encountered for 1982 also corresponded to rather low cover of planted grasses. Possible reasons for low cover of planted grasses have been discussed above.

Shrub cover for 1982 samples averaged 11.6 percent on the control portion and 15.6 percent on the treatment side of Plot R-3 (Table 6-9). These cover values corresponded to 26.7 and 35.6 percent of total cover averaged over all treatment combinations and growth forms for the respective portions of R-3. The highest cover on either portion of R-3 was recorded on plots seeded at the high rate but which received no mulch. However, relatively high cover also was noted for various other mulch and seeding combinations (Table 6-9). Invaded shrub species averaged 1.4 percent cover on control and 0.6 percent cover on the treatment portion of Plot R-3. Winterfat and fourwing saltbush were the two planted species contributing most to shrub cover. Although providing considerably less cover than the aforementioned species, rubber rabbitbrush and bitterbrush (Purshia tridentata) were encountered frequently. Broom snakeweed was the primary invaded shrub species encountered on Plot R-3 (Appendix 6-1.5).

When planted or invaded shrub cover for 1982 was compared among treatment combinations, no significant main or interaction effects were noted (Table 6-11). If these same data were partitioned by species, however, rubber rabbitbrush stood out as having significant main effect differences based on substrate, mulch and seeding treatments (Table 6-12). Duncan's Multiple Range Test results indicated that rabbitbrush was favored by hydromulch, low seeding rates, and processed shale substrate (Appendix 6-1.6). The potential for reduced competition from other planted species within areas seeded at the low rate may be one reason for higher cover of rabbitbrush. If this is indeed the case, it is unclear why other shrub species have not responded similarly. Furthermore, it is surprising that rabbitbrush was the only shrub favored by a particular mulch treatment. It is possible that rabbitbrush was in some way favored by the shale substrate, but it is unclear which shale-related parameter would elicit a favorable growth response.

Shrub cover for planted species has varied significantly among years, as indicated by results of a one-way ANOVA (Table 6-13). These differences are illustrated by Duncan's Multiple Range Test results (Appendix 6-1.6), which show that cover recorded for 1979 and 1982 was significantly higher

than for the four remaining sample periods. Variations in shrub cover are also evident on Table 6-10. The high cover for 1979 relative to 1980 or 1981 is reasonable when one recalls that clipping of shrubs occurred after cover estimates had been determined during the 1979 sample period. In the two subsequent sampling periods (1980, 1981) cover was assessed on these same quadrats. As expected, shrub species, being somewhat slower growing, were slower in their recovery after clipping than herbaceous species. Shrub cover for 1982 was relatively high because cover was assessed on newly established quadrats, none of which had been impacted by clipping.

b. Biomass Data - Biomass for grasses and forbs on Plot R-3 was determined July 26-August 5, 1982 after cover estimates had been made. These data are summarized on Table 6-14 and are presented in their entirety in Appendix 6-1.5.

Biomass for herbaceous species averaged 84.9 gm/$m^2$ (849 kg/ha) on the control portion of R-3, with a range from 61.5 to 111.4 gm/$m^2$ (Table 6-14). Standing crop on the treatment portion of the study area was slightly lower (79.1 gm/$m^2$, 791 kg/ha), with a range of from 62.5 to 107.6 gm/$m^2$.

Planted grass species accounted for 77 percent of the average standing crop for herbaceous species on the control side and 80.7 percent on the treatment portion of R-3. The high proportion of biomass attributed to grasses was expected due to the high cover and the clumped growth characteristics of several species.

A comparison of biomass for planted and invaded grasses among treatment combinations indicated that there were no significant main or interaction effect differences (Table 6-15). However, when the data were partitioned by species rather than by growth form, two grass species had significant main effect differences (Table 6-16). Wheatgrass species and pubescent wheatgrass were both influenced by seeding rate. Duncan's Multiple Range Test results illustrated that biomass of wheatgrass species was significantly higher on plots seeded at the lowest rate than on those seeded at the highest rate (Appendix 6-1.6). Pubescent wheatgrasss, on the

TABLE 6-14. BIOMASS (GM/M2) OF PLANTED AND INVADED GRASSES, AND FORBS FOUND IN EXPERIMENTAL REVEGETATION PLOT R-3 (SUBPLOTS 4, 5, AND 6), DURING THE CURRENT REPORTING YEAR, 1982

| TREATMENTS COMBINATIONS | CONTROL (NO PROCESSED SHALE) | | | | | TREATMENT (PROCESSED SHALE) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | TOTAL GM/M2 | GRASSES PLANTED | GRASSES INVADED | FORBS PLANTED | FORBS INVADED | TOTAL GM/M2 |
| HAY MULCH LOW SEEDING | 50.3 | 12.2 | 3.2 | 0.6 | 66.3 | 71.7 | 10.5 | 3.0 | 1.8 | 87.0 |
| HYDROMULCH LOW SEEDING | 38.5 | 9.9 | 12.3 | 0.9 | 61.5 | 51.2 | 1.3 | 12.3 | 1.9 | 66.8 |
| NO MULCH LOW SEEDING | 54.7 | 4.0 | 7.0 | 3.8 | 69.5 | 48.3 | 1.8 | 6.6 | 0.9 | 57.6 |
| HAY MULCH MEDIUM SEEDING | 51.2 | 27.2 | 4.2 | 0.2 | 82.8 | 46.5 | 11.7 | 3.9 | 0.4 | 62.5 |
| HYDROMULCH MEDIUM SEEDING | 64.2 | 4.9 | 5.5 | 0.3 | 75.0 | 76.1 | 8.3 | 23.1 | 0.0 | 107.6 |
| NO MULCH MEDIUM SEEDING | 68.3 | 1.8 | 11.0 | 3.1 | 84.3 | 72.5 | 3.0 | 10.1 | 0.5 | 86.2 |
| HAY MULCH HIGH SEEDING | 73.2 | 3.7 | 28.4 | 1.1 | 106.4 | 68.6 | 10.5 | 2.6 | 0.8 | 82.5 |
| HYDROMULCH HIGH SEEDING | 86.2 | 1.3 | 18.4 | 0.5 | 106.4 | 72.6 | 0.7 | 17.2 | 0.1 | 90.6 |
| NO MULCH HIGH SEEDING | 101.9 | 0.6 | 8.0 | 0.9 | 111.4 | 66.3 | 0.7 | 3.8 | 0.5 | 71.4 |
| MEAN BIOMASS | 65.4 | 7.3 | 10.9 | 1.3 | 84.9 | 63.8 | 5.4 | 9.2 | 0.8 | 79.1 |

Table 6-15. Results of a Three-way ANOVA Comparing Aboveground Biomass ($gm/m^2$) for Planted and Invaded Grass and Forb Species During 1982 on Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Substrate | | Mulch | | Seeding | | Substrate x Mulch | | Substrate x Seeding | | Mulch x Seeding | | Substrate x Mulch x Seeding | |
| | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] |
| Grasses Planted | 0.18 | 0.6691 | 0.24 | 0.7885 | 1.59 | 0.2083 | 0.49 | 0.6136 | 0.51 | 0.6006 | 0.46 | 0.7644 | 0.08 | 0.9870 |
| Grasses Invaded | 0.29 | 0.5935 | 2.80 | 0.0696 | 0.78 | 0.4641 | 0.14 | 0.8708 | 0.50 | 0.6114 | 0.19 | 0.9426 | 0.54 | 0.7036 |
| Forbs Planted | 0.18 | 0.6706 | 1.60 | 0.2096 | 1.08 | 0.3453 | 0.89 | 0.4160 | 1.14 | 0.3271 | 0.68 | 0.6084 | 0.54 | 0.7082 |
| Forbs Invaded | 0.83 | 0.3671 | 1.13 | 0.3352 | 1.30 | 0.2835 | 3.00 | 0.0615 | 0.50 | 0.6084 | 0.18 | 0.9475 | 1.00 | 0.4181 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effect differences are presented in Appendix 6-1.6.

2/ Represents the significance probability ($\alpha$) associated with F.

Table 6-16. Results of a Three-way ANOVA Comparing Aboveground Biomass ($gm/m^2$) for Planted Species Encountered During 1982 on Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation: Substrate F | Substrate PR>F[2/] | Mulch F | Mulch PR>F[2/] | Seeding F | Seeding PR>F[2/] | Substrate x Mulch F | Substrate x Mulch PR>F[2/] | Substrate x Seeding F | Substrate x Seeding PR>F[2/] | Mulch x Seeding F | Mulch x Seeding PR>F[2/] | Substrate x Mulch x Seeding F | Substrate x Mulch x Seeding PR>F[2/] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses Planted | | | | | | | | | | | | | | |
| Agropyron species | 1.71 | 0.2083 | 0.71 | 0.5076 | 5.07** | 0.0188 | 0.07 | 0.9339 | 0.89 | 0.4292 | 0.70 | 0.6044 | 0.01 | 0.9996 |
| Agropyron trichophorum | 1.81 | 0.1985 | 0.99 | 0.3930 | 22.38** | 0.0001 | 0.09 | 0.9143 | 0.77 | 0.4791 | 0.63 | 0.6456 | 0.50 | 0.7393 |
| Bromus inermis | 0.91 | 0.3527 | 2.64 | 0.1003 | 2.24 | 0.1372 | 1.16 | 0.2290 | 0.43 | 0.6591 | 0.86 | 0.5096 | 0.77 | 0.5590 |
| Oryzopsis hymenoides | 0.00 | 0.9835 | 0.64 | 0.5388 | 1.97 | 0.1740 | 0.31 | 0.7349 | 0.23 | 0.7958 | 0.94 | 0.4675 | 0.89 | 0.4934 |
| Stipa viridula | 0.23 | 0.6384 | 0.73 | 0.5064 | 0.44 | 0.6585 | 0.34 | 0.7214 | 0.23 | 0.7979 | 1.25 | 0.3278 | 0.22 | 0.6492 |
| Forbs Planted | | | | | | | | | | | | | | |
| Astragalus cicer | 0.24 | 0.6297 | 3.49 | 0.0538 | 0.59 | 0.5665 | 0.35 | 0.7066 | 0.23 | 0.8008 | 0.27 | 0.8938 | 0.46 | 0.7611 |
| Linum lewisii[3/] | 5.34 | 0.2600 | 5.47 | 0.2895 | 2.39 | 0.4159 | 5.64 | 0.2854 | 0.23 | 0.7129 | | | | |
| Melilotus officinalis | 0.82 | 0.3795 | 1.87 | 0.1882 | 0.71 | 0.5055 | 0.76 | 0.4844 | 0.80 | 0.4673 | 1.14 | 0.3769 | 1.17 | 0.3625 |

* Significant at $\alpha = 0.05$

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effects differences are presented in Appendix 6-1.6.

2/ Represents the significance probability ($\alpha$) associated with F.

3/ Missing values result from insufficient data to complete the ANOVA.

other hand, had significantly different biomass for each of the different seeding treatments, with the highest standing crop corresponding to the highest seeding rate. These results corresponded directly with the results noted for cover of these two categories of wheatgrasses.

When two years of biomass determinations were compared, neither grass category was significantly different among years at the five percent level (Table 6-17). In 1979 planted grasses averaged 80.5 gm/$m^2$, as compared to 64.6 gm/$m^2$ during 1982 (RBOSC 1980). This decrease in aboveground biomass for planted species corresponded with an increase for invaded species from 3.3 to 6.4 gm/$m^2$. These differences between years may be due, in part, to sampling error related to the random plot selection for newly established quadrats in 1982.

The standing crop for planted forb species averaged 10.9 gm/$m^2$ (109 kg/ha) on the control portion and 9.2 gm/$m^2$ (92 kg/ha) on the treatment side (Table 6-14). The range in biomass for the control portion was from 3.2 to 28.4 gm/$m^2$ while that on the treatment side was from 2.6 to 23.1 gm/$m^2$. Planted forb species accounted for approximately 12 percent of the standing crop of all herbaceous species averaged over all treatment combinations. Invaded forb species, on the other hand, contributed an average of only 1.3 percent of herbaceous species biomass, or 1.05 gm/$m^2$ (10.5 kg/ha).

A statistical comparison of forb biomass among treatment combinations for 1982 indicated no significant main or interaction effect differences for either planted or invaded species (Table 6-15). Analyses after partitioning the biomass by planted species indicated that no significant differences exist (Table 6-16). However, biomass was significantly different for planted forbs species between the 1979 and 1982 sampling periods (Table 6-17). The mean biomass of 10.0 gm/$m^2$ (100.5 kg/ha) recorded for 1982 was significantly higher than the 3.5 gm/$m^2$ (35 kg/ha) encountered during 1979 (Appendix 6-1.6; RBOSC 1980). As noted with grasses, there seemed to be an inverse relationship between biomass of planted and invaded forb species. As the mean biomass of planted species tripled from 1979 to 1982, the standing crop of invaded forb species

Table 6-17. Results of a One-Way ANOVA Comparing Aboveground Biomass of Planted and Invaded Grasses and Forbs for 1979 and 1982 on Experimental Revegetation Plot R-3, Tract C-a[1/]

| Growth Form | Source of Variation Year | |
|---|---|---|
| | F | PR>F [2/] |
| Grasses Planted | 3.31 | 0.0700 |
| Grasses Invaded | 0.74 | 0.3902 |
| Forbs Planted | 12.53** | 0.0005 |
| Forbs Invaded | 0.88 | 0.3509 |

** Significant at $\alpha = 0.025$

[1/] Duncan's Multiple Range Test results for significant main effect differences are presented in Appendix 6-1.6.

[2/] Represents the significance probability ($\alpha$) associated with F.

declined from 2.0 to 0.7 gm/$m^2$. Much of the reduction in biomass of invaded forb species seemed to be related to Russian thistle, which was not encountered in 1982 but contributed an average of 1.6 gm/$m^2$ in 1979. This is not to say that there is a cause and effect relationship between planted and invaded forbs, but rather that competition from all planted species contributes to the demise of invaded species, which are not able to compete with the more aggressive planted species after several years.

As noted above, shrubs were not assessed for aboveground biomass during 1982. However, during the 1979 sample period shrubs accounted for approximately 58 percent of 2151 kg/ha mean biomass. Shrub cover for 1982 (13.6 percent) nearly equalled that for 1979 (16.7 percent) so, had they been clipped during 1982, shrubs may have accounted for the majority of aboveground biomass on Plot R-3.

c. Precipitation - Rainfall at Plot R-3 totalled 10.64 inches for April-October 1982 (Table 6-18). The highest precipitation occurred during September when an average of 3.73 inches of rain was recorded. The highest mean monthly precipitation, averaged over the previous five year period, was 1.59 inches for August (RBOSC 1982). The characteristically low precipitation for the month of June was again evident on Plot R-3. However, unlike the previous five year period when July precipitation averaged 1.2 inches, the low rainfall continued into July during the 1982 reporting period. Inspite of low precipitation for this two-month period, the 1982 seven month total was the highest recorded since Plot R-3 was established in 1976.

d. Soil Chemistry and Trace Element Analyses - Soil conductivity data, as illustrated on Table 6-19, showed little change from those recorded during earlier sample periods. Conductivity increased with depth in the reconstructed soil profiles on both the treatment and control portions of Plot R-3. This increase appears to be related to increases in the proportion of unweathered material with increased depth rather than the shale-no shale substrate. A statistical comparison of 1982 conductivity data between control and treatment portions of Plot R-3 indicated that, for

Table 6-18. Rainfall (inches) Recorded at Experimental Regevetation Plots R-1, R-2 and R-3 during 1982, Tract C-a.

| Month | Plot R-1 | | Plot R-2 | | Plot R-3 | | Mean |
|---|---|---|---|---|---|---|---|
| | Upper | Lower | Upper | Lower | Upper | Lower | |
| April | 0.75 | 0.80 | 0.72 | 0.78 | 0.76 | 0.79 | 0.77 |
| May | 1.09 | 1.09 | 1.17 | 1.21 | 1.18 | 1.30 | 1.17 |
| June | 0.41 | 0.38 | 0.37 | 0.39 | 0.39 | 0.41 | 0.39 |
| July | 0.37 | 0.35 | 0.40 | 0.45 | 0.47 | 0.48 | 0.42 |
| August | 1.91 | 1.81 | 2.02 | 2.02 | 2.14 | 2.15 | 2.00 |
| September | 3.65 | 3.69 | 3.69 | 3.78 | 3.76 | 3.70 | 3.71 |
| October | 1.63 | 1.62 | 1.61 | 1.72 | 1.78 | 1.98 | 1.72 |
| Guage Total | 9.81 | 9.74 | 9.98 | 10.35 | 10.48 | 10.81 | |
| Plot Mean | 9.78 | | 10.16 | | 10.64 | | 10.18 |

Table 6-19. A Comparison of Mean Electrical Conductivity (mmhos/cm) Between Control (No Shale) and Treatment (Shale) Substrates[1/]

| Substrate | Depth (cm) | Year | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1976 | 1977 | 1978 | 1979[2/] | 1980[2/] | 1981 | 1982 |
| Control | 0 | 0.26 | 0.20 | 0.28 | 0.18 | 0.23 | 0.16 | 0.12 |
| | 25 | 0.31 | 0.26 | 0.27 | 0.23 | 0.25 | 0.18 | 0.21 |
| | 50 | 0.56 | 0.57 | 0.42 | 0.51 | 0.42 | 0.24 | 0.35 |
| Treatment | 0 | 0.28 | 0.20 | 0.26 | 0.23 | 0.27 | 0.18 | 0.12 |
| | 25 | 0.38 | 0.26 | 0.28 | 0.33 | 0.27 | 0.17 | 0.23 |
| | 50 | 0.45 | 0.50 | 0.40 | 0.32 | 0.36 | 0.26 | 0.36 |

[1/] EC is based on a 1:2 soil-water extract.

[2/] Data are converted to values which correspond to a 1:2 soil-water extract.

a given sample depth, there were no significant differences in conductivity (Appendix 6-1.6).

These results indicated that, from the aspect of movement of salts, the reconstructed soil profile continued to provide a reasonable environment for plant growth. Based on excavations accomplished during 1982, it appeared that the rubblized overburden layer of the reconstructed profile no longer has void spaces which would inhibit capillary migration of dissolved salts from the processed shale into the topsoil-like materials. Therefore, it is reasonable to assume that moisture is not moving downward through the reconstructed profile in quantities sufficient for dissolution and subsequent upward transport of salts.

During the excavation of a portion of the reconstructed soil profile, it was noted that most roots penetrated only to approximately 70 cm. However, a very small percentage of the roots extended through the reconstructed profile and made contact with the processed shale. In order to ascertain whether or not trace elements from the processed shale were being taken up by the planted vegetation, aboveground vegetative portions of five plant species were collected from control and treatment portions of Plot R-3, and these materials were analyzed for arsenic, boron, fluoride, molybdenum and selenium (Appendix 6-1.5). Mean values, based on three replicates for each species from both control and treatment portions of Plot R-3, are presented on Table 6-20. Statistical comparisons of these data indicated that boron content in tissues of rubber rabbitbrush (Chrysothamnus nauseosus) was significantly higher on the control side of Plot R-3 than on the treatment side (Appendix 6-1.6). Because levels of boron in tissues of rabbitbrush collected from the control portion (54.9 ppm) were higher than those from the portion underlain with processed shale (treatment side) (39.5 ppm), some factor other than uptake from the shale must be contributing to high boron levels in rabbitbrush. Higher concentrations of boron in shrubs relative to herbaceous species are not unexpected. Similar results have been reported by Ostler (1981) and Kilkelly and Lindsay (1981). No other significant differences were noted. Nevertheless, when determinations for trace elements within plant materials were compared with values from R-3

Table 6-20. Mean Trace Element Content (ppm) for Five Plant Species Growing on Experimental Revegetation Plot R-3 During 1982.

| Plant Species | Arsenic | | Boron | | Fluoride | | Molybenum | | Selenium | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment | Control | Treatment |
| Agropyron trichophorum | 0.13 | 0.10 | 18.4 | 19.8 | 1.9 | 2.7 | 1.4 | 2.2 | 0.11 | 0.10 |
| Atriplex canescens | 0.12 | <0.10 | 55.1 | 50.8 | 3.7 | 2.5 | 3.5 | 1.3 | 0.13 | 0.10 |
| Chrysothamnus nauseosus | <0.10 | <0.10 | 54.9* | 39.5* | 4.3 | 3.3 | 1.0 | 1.2 | <0.10 | <0.10 |
| Linum lewisii | <0.10 | <0.10 | 24.6 | 29.7 | 4.1 | 3.7 | 1.1 | 1.3 | <0.10 | <0.10 |
| Oryzopsis hymenoides | <0.10 | <0.10 | 13.5 | 12.9 | 1.9 | 2.3 | 1.1 | 1.2 | <0.10 | <0.10 |

* Significantly different at $\alpha = 0.05$

soil samples (Appendix 6-1.5), it appeared that all of the trace elements tested were accumulated to some extent from natural soils by the five plant species, regardless of the shale-no shale substrate.

## 6.2 MULE DEER HABITAT MODIFICATION STUDY

### 1. Objectives

During RBOSC's commercial operation, disturbances of the land will result in the loss of habitat and forage for wildlife, primarily mule deer. One means of mitigating these losses is to increase the mule deer carrying capacity of undisturbed areas to maintain the overall carrying capacity at, or near, predevelopment levels. RBOSC initiated an experiment in 1980 to determine the feasibility of producing such increases in carrying capacity using the habitat modification techniques described below.

### 2. Methods

The critical factor which currently limits mule deer populations in the Piceance Creek Basin is the availability of suitable food during periods of heavy snow cover. Thus, a program designed to increase the carrying capacity of local habitats for mule deer should be aimed at increasing suitable forage as well as providing access for mule deer to these modified areas during periods of heavy snow cover. Habitat modification in large, continuous blocks increases wildlife forage, but such large areas commonly fill with snow during periods of heavy snowfall making the area inaccessible to deer. The RBOSC habitat modification program is designed to avoid this problem by modifying vegetation in strips, leaving the vegetation between strips undisturbed. The undisturbed strips provide cover and access routes to the modified areas. The RBOSC study design is discussed in further detail in MDP Monitoring Report Nine (RBOSC 1982). The location of the study site is illustrated in Figure 6-4.

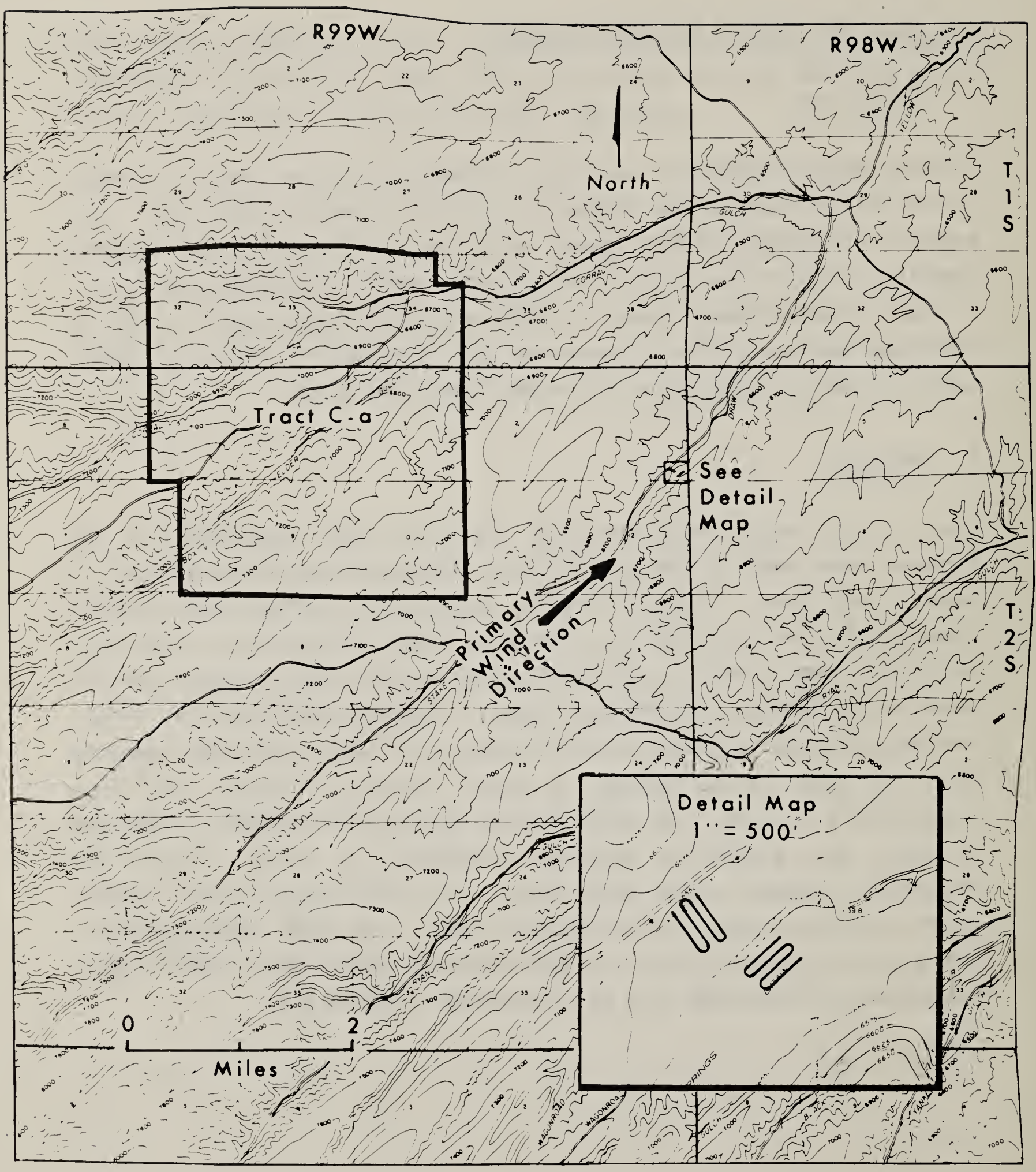



Figure 6-4. Location of Mule Deer Habitat Modification Study

## 3. Results and Discussion

Cover and density for the 1982 period were assessed August 9-10, 1982. These data are presented in their entirety in Appendix 6-2.1.

Prior to analysis using a three-way ANOVA, data from the parallel and perpendicular corridor orientations were compared using a t-test procedure to determine if the cover and/or density means were equal. In both instances there were significant differences between means for the two corridor orientations; consequently, data from each orientation were treated separately in the subsequent ANOVA's (Appendix 6-2.2).

Results of the three-way ANOVA's showed that significant main effect differences (chopping and fertilization) existed throughout the study area aligned parallel to the prevailing winds but not the area aligned perpendicular to the wind (Table 6-21). Duncan's Multiple Range Test results indicated that density of shrubs was significantly higher on rotochopped segments of the transects than on unchopped segments of the site aligned parallel to the wind (Appendix 6-2.2). An inspection of the data showed that this was related primarily to increased numbers of sagebrush (Artemisia tridentata) individuals. Sprouting from roots and/or germination of sagebrush seed in chopped areas undoubtedly have contributed to this high density.

Cover of shrubs and/or herbaceous species appeared to be related to both fertilization and rotochopping on the parallel orientation site. Cover was significantly higher on fertilized and non-rotochopped treatments. One would expect that cover would increase with fertilization as well as on portions that had been rotochopped. However, in the case of rotochopping this did not appear to be substantiated by the 1982 data. One obvious reason for this apparent discrepency was the use of both shrub and herbaceous species in the ANOVA's. In order to get sufficient data to attain ANOVA results, all growth forms must be included. Cover of sagebrush will be high in unchopped areas, hence the significant differences in cover.

Table 6-21. Results of Three-way ANOVA's For Density and Arcsine Transformed Cover Estimates for 1982 on Mule Deer Habitat Modification Study Areas[1/]

| Corridor Orientation | Source of Variation | | | | | |
|---|---|---|---|---|---|---|
| | Fertilizer | | Seeding | | Chopping | |
| | F | PR>F [2/] | F | PR>F [2/] | F | PR>F [2/] |
| Parallel to Wind | | | | | | |
| Density | 0.75 | 0.3863 | 0.20 | 0.6586 | 10.69** | 0.0013 |
| Cover | 12.97** | 0.0004 | 1.60 | 0.2067 | 7.40** | 0.0068 |
| Perpendicular to Wind | | | | | | |
| Density | 1.52 | 0.2183 | 0.00 | 0.9513 | 0.24 | 0.6257 |
| Cover | 2.19 | 0.1395 | 2.05 | 0.1528 | 0.13 | 0.7208 |

** Significant at $\alpha = 0.025$

1/ Duncan's Multiple Range Test results for significant main effect differences are presented in Appendix 6-3.2.

2/ Represents the significance probability ($\alpha$) associated with F.

In spite of the aforementioned differences based on chopping and/or fertilization, very few of the planted species appeared to be doing well. Aside from an occasional occurrence of wheatgrass species or alfalfa, most individuals encountered were non-planted species. In the case of shrubs, many of these species were already growing on or near the site prior to chopping. To a lesser extent, the same was true for herbaceous species; however, grasses and forbs, due to their lower stature, may have been more obscure than the shrubs. Seeds from all these plants were probably present, though dormant, prior to chopping. With increased light and reduced competition from sagebrush, these seeds germinated resulting in an influx of non-planted species. Although some of these non-planted species may serve as increased forage for wildlife, the species planted for this purpose are not. It is uncertain whether or not these species will increase in cover during future growing seasons.

Furthermore, because the mild winter with limited snow cover allowed deer access to adequate food supplies over much of the area around Tract C-a, deer use of the modified sagebrush site during 1982 was minimal. Too few pellet groups were found along any of the transects to determine differential deer use.

## 6.3 SHRUB GROWTH ENHANCEMENT ON A SIMULATED MINE SITE AND/OR DISPOSAL PILE BENCH

### 1. Objectives

Reclamation of areas disturbed by Tract C-a activities will be accomplished according to a state and federally approved reclamation plan. Reclamation techniques implemented by RBOSC are expected to result in adequate habitat for livestock and wildlife. However, any additional steps which might reduce the amount of time necessary to establish such habitat are desirable. Shrub growth enhancement through water harvesting techniques is an example of such a step. The objective of this study is to test such techniques as a means of habitat establishment and enhancement.

In the semiarid environment of the Piceance Basin, increased shrub growth may be achieved by augmenting soil moisture via water harvesting techniques. Water harvesting is a technique designed to conserve and more efficiently utilize normal runoff by concentrating runoff from a large area into a smaller area.

To reduce the potential for soil erosion, benches will probably be required on large slopes resulting from Tract C-a mining and/or disposal activities. To test the influence of increased moisture on shrub growth for wildlife cover, water harvesting techniques are being incorporated into a simulated mine site/disposal pile bench on a south-facing slope within Box Elder Gulch on Tract C-a.

### 2. Methods

The design of the simulated mine site/disposal pile bench is presented in Figures 6-5 and 6-6. Water from accumulated snowpack, and runoff from snow melt and rainfall should concentrate along the two rows of shrubs on the 6:1 (horizontal:vertical) bench slope (Rows B and C). Increased moisture should also be available to the shrubs in the water bar below the bench (Row E). The rows of shrubs on the 3:1 slope between the bench and the

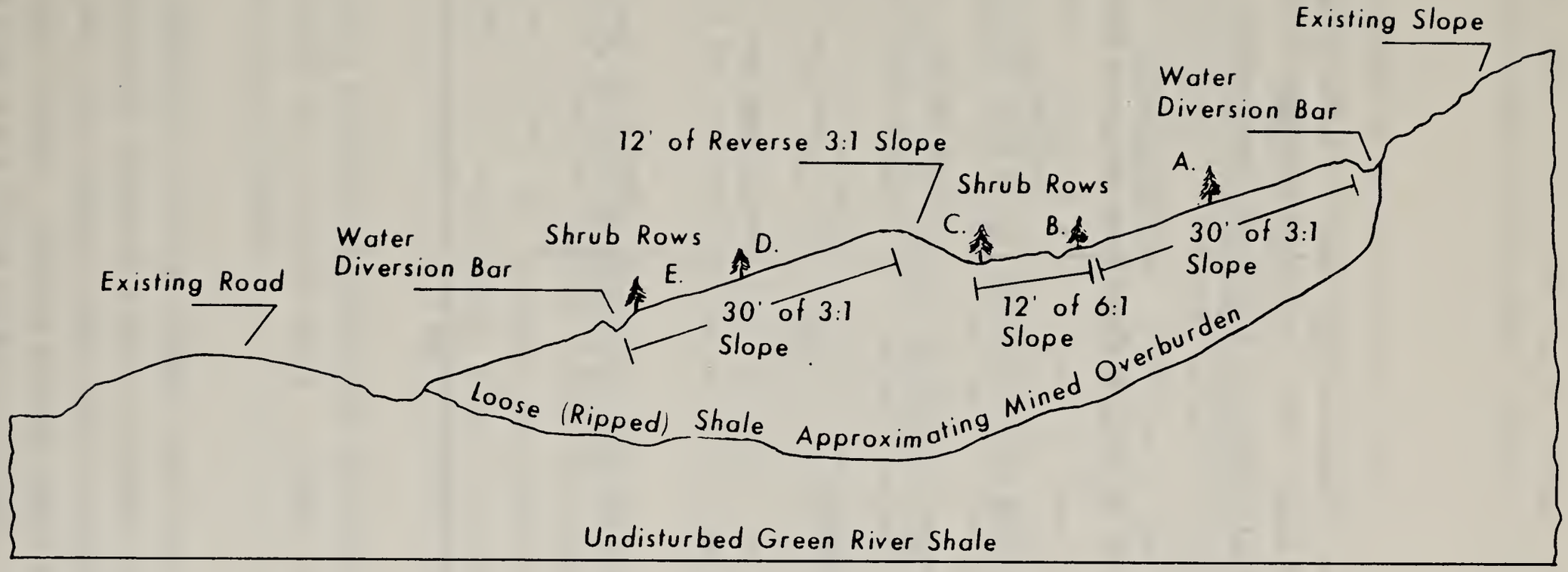



Figure 6-5. Cross Section of Simulated Mine Bench for Testing of Shrub Growth through Water Harvesting.

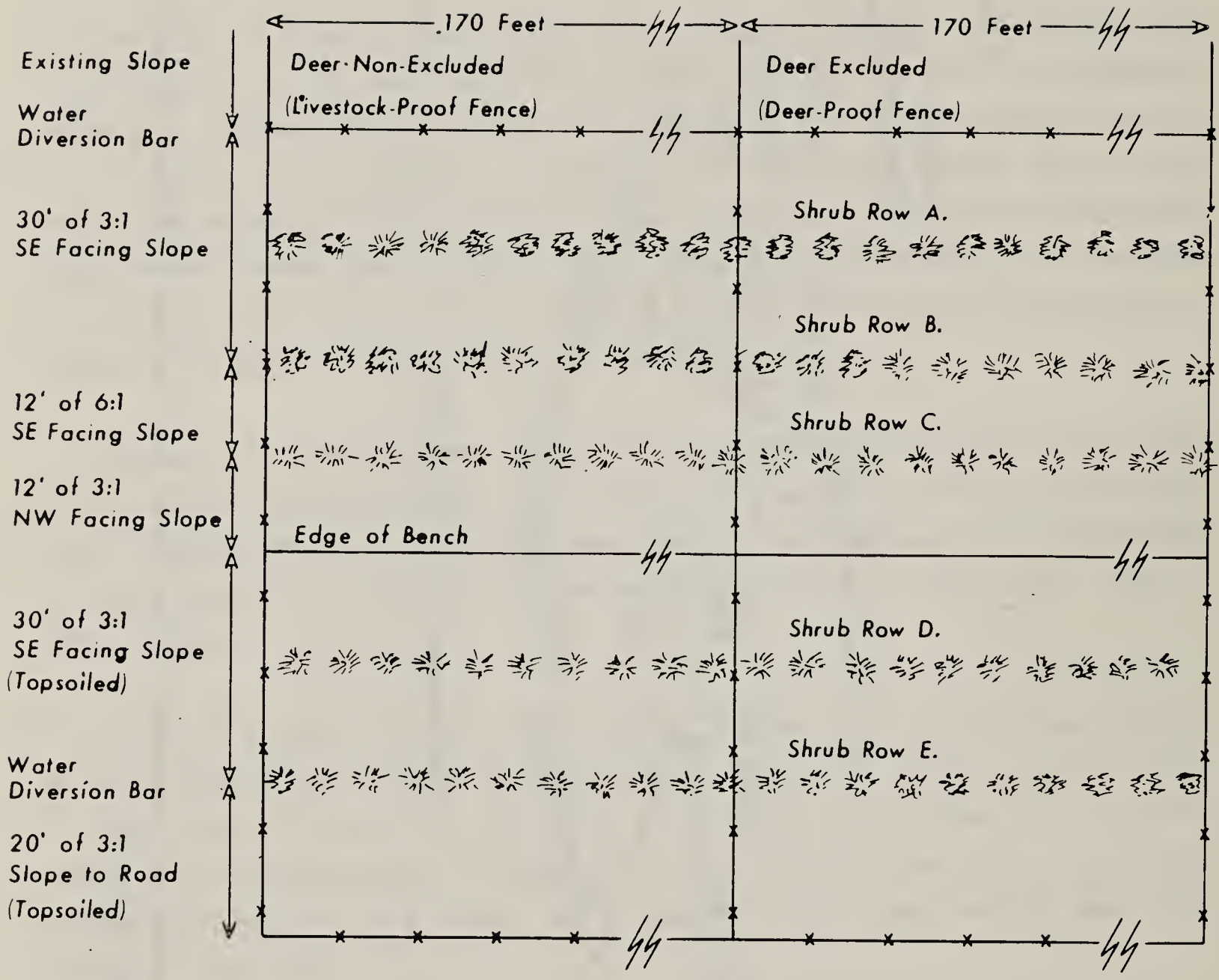



Figure 6-6. Aerial View of Simulated Mine Bench for Testing Enhancement of Shrub Growth through Water Harvesting

lower water bar (Row D), and the row of shrubs above the bench (Row A) serve as controls, where shrub growth without increased moisture will be monitored.

In order to establish wildlife cover rapdily, six of the seven shrub species planted in the test area are not normally used as food by deer: fourwing saltbush (Atriplex canescens), New Mexico foresteria (Foresteria neomexicana), Apache plume (Fallugia paradoxa), New Mexico black locust (Robinea neomexicana), old man wormwood (Artemisia abrotanum), and Skunkbrush sumac (Rhus trilobata). Serviceberry (Amelanchier alnifolia), a choice deer food, was included to test the effect of deer browsing pressure on shrub growth. One-half of the test is fenced to exclude deer and cattle, and the other half is fenced to exclude cattle but allow deer entry. All shrub species were planted as tublings in June of 1982. Shrubs were watered at the time of planting and irrigated as necessary during the first summer to ensure establishment; if necessary, one-half of all shrub rows on the bench and in the waterbar will be irrigated for the following two summers, to test the effect of irrigation on shrub growth. All areas between shrub rows were planted with the RBOSC seed mixture illustrated on Table 6-22.

In order to test the effectiveness of the water harvesting technique, moisture content is measured monthly during the growing season within the soil profiles on control and treatment portions of the simulated bench. Permanently placed soil access tubes allow for repeated soil moisture determinations at the same locations using a Troxler Soil Moisture Probe.

Shrub growth rate is determined by measuring the plant height and diameter of each individual on a seasonal basis. Growth rate of each species is compared for each shrub treatment.

Success of revegetation efforts between shrub rows is monitored along permanently established transects within treatment areas. Transects are placed during the first growing season after planting and are marked at both ends with rebar stakes. Aluminum marking tags identifying the

Table 6-22. Seed Mixture Used in Final Reclamation by RBOSC

| Plant Species | Seeding Rate (Kg/Ha) |
|---|---|
| Pubescent Wheatgrass (Agropyron trichophorum) | 3.0 |
| Western Wheatgrass (Agropyron smithii) | 4.2 |
| Streambank Wheatgrass (Agropyron riparium) | 2.4 |
| Indian Ricegrass (Oryzopsis hymenoides) | 1.8 |
| Green Needlegrass (Stipa viridula) | 1.8 |
| Smooth Brome (Bromus inermis) | 1.8 |
| Cicer Milkvetch (Astragalus cicer) | 1.8 |
| Yellow Sweetclover (Melilotus officinalis) | 0.9 |
| Lewis Flax (Linum lewisii) | 1.2 |
| Winterfat (Ceratoides lanata) | 1.2 |
| Fourwing Saltbush (Atriplex canescens) | 1.2 |
| Bitterbrush (Purshia tridentata) | 1.2 |
| TOTAL | 22.50 |

transect number, as well as the beginning and/or end of the transect, are attached to these stakes. Transects are 40 m in length and are oriented perpendicular to the existing slope whenever possible.

Cover of grasses, forbs, and shrubs is estimated annually within sampling frames (1 $m^2$) placed at five-meter intervals along the transects. A meter tape stretched between the stakes at either end of the transect allows exact placement of these frames. Sampling frames are sub-divided into one-twentieth area segments and cover of individual species is estimated to the nearest one percent. All data are recorded on field data forms, which are formatted for direct computer entry.

## 3. Results and Discussion

This study was established in 1982, but data collection will not begin until 1983. Results will be reported in future monitoring reports.

## 6.4 STUDY TO ALTER NATURAL SUCCESSION AFTER FIRE FOR ENHANCED DEER-LIVESTOCK FORAGE

### 1. Objectives

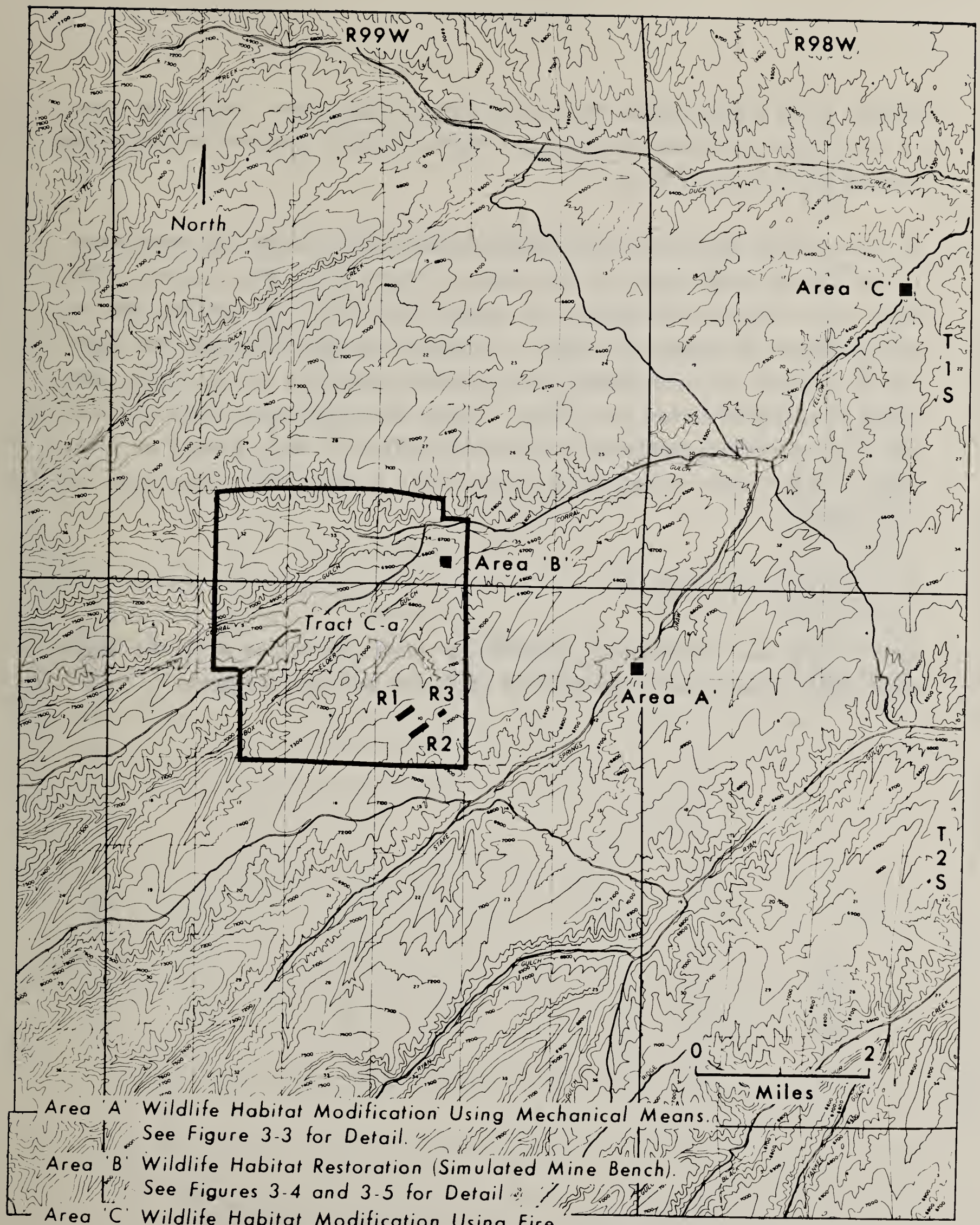
During RBOSC's commercial operation, disturbance of land will result in the loss of forage for wildlife, including mule deer, and for livestock. One means of mitigating these losses is to increase the amount of available forage in undisturbed areas thereby maintaining carrying capacity in the area at, or near, predevelopment levels. RBOSC initiated an experiment in 1982 to determine the feasibility of producing such increases using the habitat modification techniques described below.

### 2. Methods

A factor important to wintering mule deer is the availability of quality green forage early in the spring. Spring "green-up" time is a period during which deer begin to recoup body nutrients lost throughout the winter. In the spring, deer congregate in large numbers in hay fields and meadows where a high density of newly emerged plant sprouts occurs. This critical forage area for deer is also an important summer grazing area for livestock.

Many creek bottoms in the vicinity of Tract C-a are covered with rank sagebrush, rabbitbrush and greasewood, and serve as wintering areas for wildlife. If a very small percentage of these bottoms were converted into areas providing quality forage for spring "green-up" and summer grazing, the carrying capacity of the region might be increased.

The use of fire to "set back" plant succession and to remove undesirable plant species is quite common (Wright et al, 1979). However, succession after several natural fires in Yellow Creek and Duck Creek northeast of Tract C-a has not resulted in vegetation more suitable for wildlife in these areas. When a natural fire occurred in September 1981 approximately 4 miles down Yellow Creek from the confluence with Corral Gulch (Figure 6-7), the opportunity was taken to set up a program to study




Area 'A' Wildlife Habitat Modification Using Mechanical Means. See Figure 3-3 for Detail.

Area 'B' Wildlife Habitat Restoration (Simulated Mine Bench). See Figures 3-4 and 3-5 for Detail

Area 'C' Wildlife Habitat Modification Using Fire. See Figure 3-6 for Detail.

R1, R2, R3 Experimental Revegetation Sites.

Figure 6-7. Terrestrial Ecology Special Study Sites

methods which might improve the suitability of vegetation. Techniques used in this study included seeding more desirable plant species and excluding grazing by livestock and deer.

In late March 1982, the plant species identified in Table 6-22 were seeded in the Yellow Creek Burn Area as shown in Figure 6-8. Two seeding rates were used (21 and 43 kg/ha), to measure the effect of seeding rate on establishment of desirable forage. Livestock has been excluded from equal sized sections of both seeded and non-seeded portions of the study area using four strand barbed wire fence. Range enclosures were placed within the livestock excluded areas to test the effect of deer grazing on plant cover. Plant cover estimates by species will be made every other year in late summer.

3. Results and Discussion

This study was established in 1982, but data collection will not begin until 1983. Results will be reported in future monitoring reports.

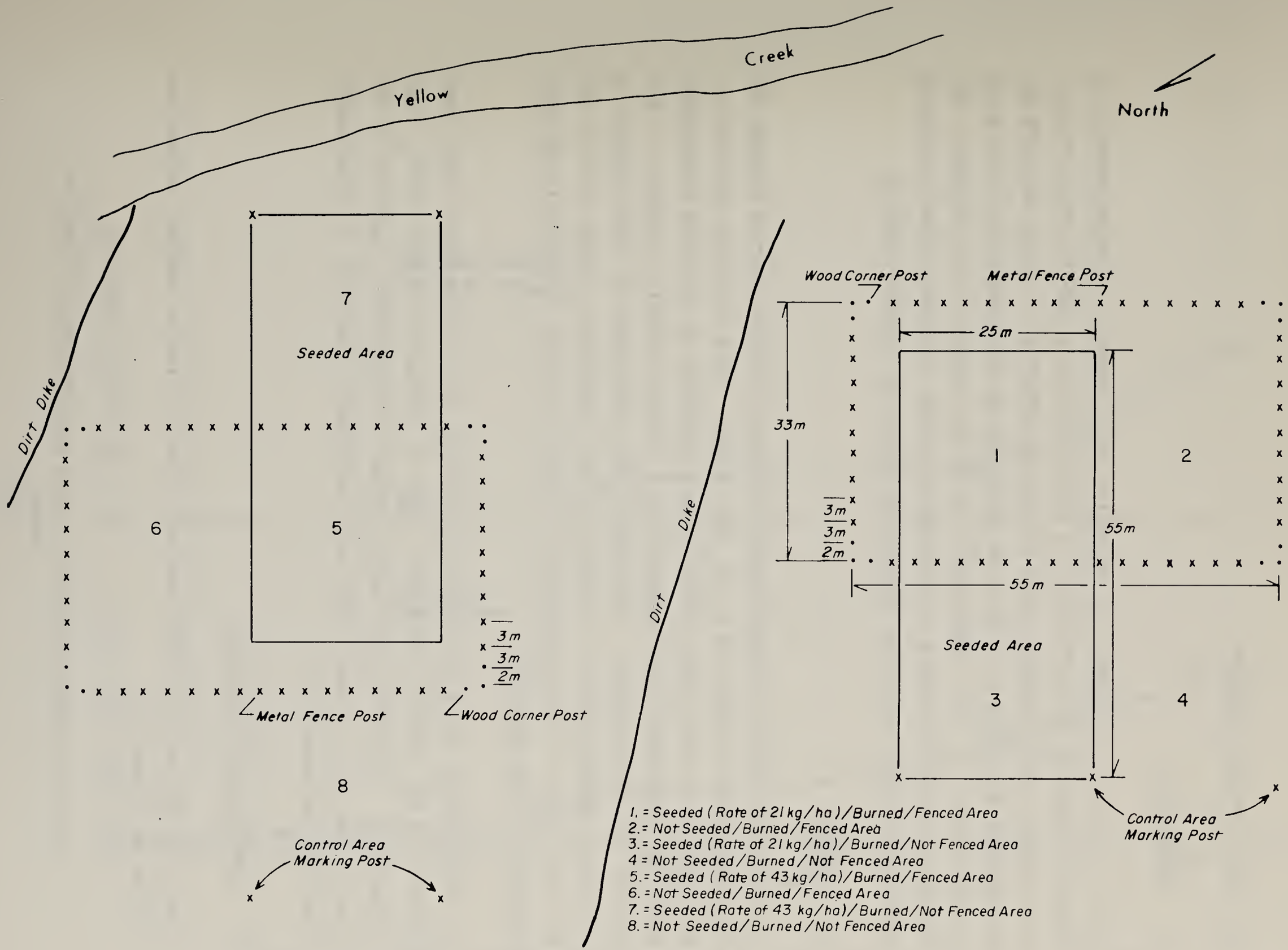



Figure 6-8. Yellow Creek Burn Area Habitat Mitigation Study Design

## 6.5 RUN-OF-MINE-LYSIMETER

### 1. Objectives

This study is designed to determine the chemical characteristics of leachate generated from raw shale in the field and to compare these results with those from laboratory tests on the same materials. These analyses and evaluations are being or are to be performed by Colorado State University researchers. This comparison is being conducted to determine the importance of such factors as percolation rates (residence time), wetting and drying cycles, and other weathering factors on leachate quality.

### 2. Methods

The field collection system consists of three collectors buried beneath the raw shale pile at depths of 5, 10, and 15 feet. Each collector consists of 10 feet x 10 feet square Teflon sheet, contoured so that the percolating water is intercepted and conducted to a Teflon drainpipe located at the center of the collector. Collectors are constructed so that leachate is collected sequentially in a series of five containers (three 2-liter and two 40-liter). As one container is filled, leachate is routed to the next container in the sequence.

A flow-through electrical resistance probe and a thermocouple have been placed in the Teflon collection line to measure conductivity and temperature. Recording rain gauges document precipitation quantity in the area of the pile. Snow depths are periodically recorded to supplement precipitation gauge data.

### 3. Results and Discussion

Tract C-a 1982 precipitation data and 5-foot collector leachate volume are plotted on Figure 6-9.

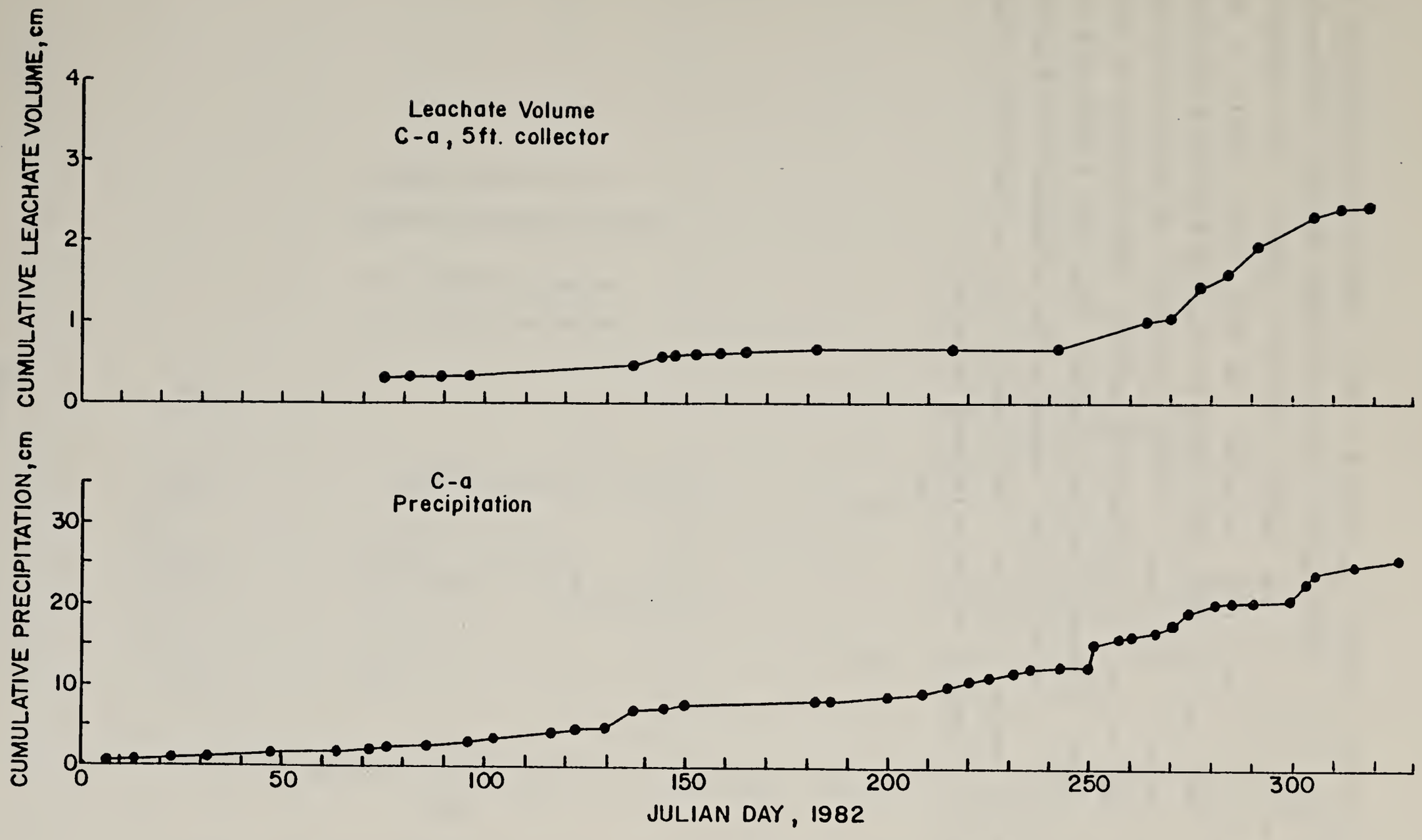



Figure 6-9. 1982 Precipitation Data and 5-Feet Collector Leachate Volume

Conductivity for 1981 and 1982 for the 5- and 15-foot collectors is shown in Figure 6-10. Data from the 10-foot collector were not collected because of malfunctions of the buried collector system. The conductivity of leachate in the 5-foot collector has been fairly stable at about 20 millimhos per cm. The conductivity of leachate from the 15-foot collector was greater in 1982 than in 1981, increasing from about 30 to about 35 millimhos per cm. Water chemistry data for 1982 are shown in Table 6-23. The primary difference between leachate from the 5-foot and 15-foot collector is the much higher concentrations of magnesium and sulfate ions from the deeper collector. The inorganic ions are dominated by magnesium sulfate in samples from both leachate collectors.

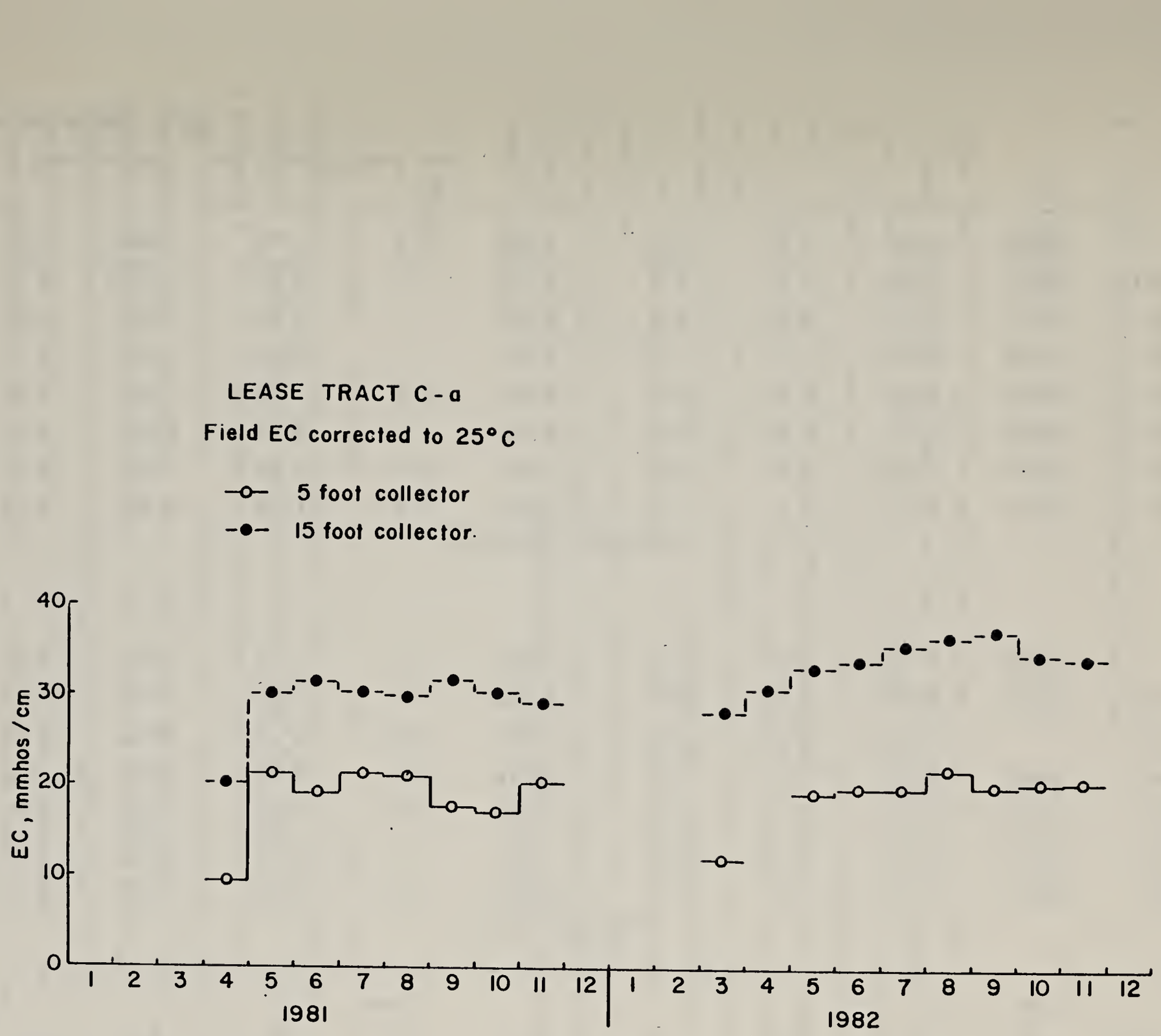



Figure 6-10. Electrical Conductivity (EC) for the 5-Foot and 15-Foot Leachate Collectors during 1981 and 1982

6-23. Major Ion Composition of Tract C-a Leachate - 1982

| Date | Ca | Mg | Na | K | $SO_4$ | Cl | $HCO_3$ | $NO_3$ | TDS | Balance* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | meq/l | | | | | mg/l | |
| | | | | | 5 Foot Collector | | | | | |
| 3-16 | 20.9 | 196.1 | 22.1 | 0.3 | 249.8 | 2.1 | 4.6 | 11.6 | 17480 | -5.4 |
| 5-24 | 18.5 | 357.7 | 38.7 | - | 500.1 | 4.6 | 5.4 | 23.3 | 30070 | -12.5 |
| 6-7 | 18.9 | 339.6 | 26.3 | 0.2 | 383.1 | 5.1 | 3.2 | 22.1 | 29550 | -3.6 |
| 7-1 | 18.8 | 373.4 | 21.4 | 0.3 | 414.3 | 5.9 | 5.4 | 22.6 | 28900 | -4.0 |
| 8-4 | 22.7 | 397.0 | 32.4 | 0.3 | 424.7 | 5.0 | 5.6 | 17.3 | - | 0.0 |
| 9-21 | 20.2 | 341.3 | 34.7 | - | 453.9 | 3.9 | 5.5 | 21.4 | 29520 | -10.0 |
| Mean** | 19.8 | 361.8 | 30.7 | 0.3 | 435.2 | 4.9 | 5.0 | 21.3 | 29510 | |
| | | | | | 15 Foot Collector | | | | | |
| 3-16 | 23.9 | 664.9 | 61.3 | 0.3 | 796.8 | 7.3 | 3.9 | 27.2 | 57350 | -5.3 |
| 4-12 | 23.5 | 786.2 | 53.7 | 0.2 | 743.3 | 8.2 | 4.5 | 32.2 | 62190 | +4.6 |
| 5-24 | 22.5 | 778.4 | 57.8 | - | 933.8 | 8.4 | 5.3 | 36.8 | 65960 | -6.8 |
| 6-2 | 19.4 | 732.7 | 55.2 | 0.2 | 784.9 | 9.3 | 6.2 | 36.6 | 64900 | -1.8 |
| 7-12 | 22.4 | 793.6 | 62.2 | - | 828.6 | 10.0 | 7.3 | 38.9 | 68410 | 0.1 |
| 8-11 | 20.7 | 996.7 | 63.0 | - | 837.0 | 8.5 | 8.8 | 32.3 | 71540 | +9.9 |
| 9-21 | 17.8 | 1127.5 | 64.8 | - | 891.1 | 8.9 | 9.5 | 35.3 | 71960 | +12.3 |
| Mean | 21.4 | 840.0 | 59.7 | 0.2 | 830.8 | 8.7 | 6.5 | 34.2 | 66040 | |

* Balance = (meq cation - meq Anion)/Total meq

** Exclusive of sample 3-16

## 6.6 SPECIAL METEOROLOGICAL INVESTIGATIONS

### A. Tracer Study of Fugitive Emissions Transport

#### 1. Objectives

Large quantities of fugitive emissions, principally fugitive dust, will be released during the production of shale. These emissions, released near the ground surface, will behave in a different manner than stack emissions. The dispersion of these emissions will be controlled by the surface winds, which are in turn strongly influenced by topography and by diurnal heating and cooling of the ground. Despite the complex physical interactions driving the surface winds, reasonably accurate predictions of resulting maximum particulate concentrations are required by current regulations. A tracer study was conducted near Tract C-a under probable worst case conditions in order to improve our understanding of the physics of low-level transport of pollutants. This work will hopefully lead to more accurate predictions of environmental impacts from fugitive dust sources in complex terrain.

#### 2. Methods

This experiment was conducted in July, 1981. A tracer gas, sulfur hexafluoride ($SF_6$), was released at a location and a height designed to simulate a major fugitive emission source from the site which had been proposed for the Lurgi demonstration plant, and is likely to be used for any future process facility. Accordingly, the tracer release was made at 1.7 meters above the ground on a ridge just to the north of Tract C-a, simulating fugitive dust emissions from a source near the surface. The terrain in the vicinity of the release point has a gentle slope to the east. Several shallow gulches running east-west serve to direct water (and air) flows down to Yellow and Duck Creeks, several miles to the east and north.

Ambient concentrations of the tracer gas were measured in air samples collected at thirty-two radio-controlled bag sampling stations, which took

15-minute samples. Additional instantaneous samples were taken with syringes along roads downwind of the release point. Both the bag and syringe samples were analyzed in a field laboratory using a portable electron-capture gas chromatograph. Details of the study are presented in a report presented at the Fifth Symposium on Fugitive Emissions (Sehmel, 1982).

## 3. Results and Discussion

Tracer releases were made during four periods, two evening runs and two early morning runs. Neither of the two evening tracer releases was very successful; the first was plagued with startup problems, including an electrical short on the radio-controlled bag samplers, while the second run was aborted due to a thunderstorm. The two morning releases, starting at approximately 0300 hours, were both run successfully. These releases began under nocturnal drainage conditions, continued through the early morning transition period after sunrise, and were completed during late morning conditions of strong insolation and good mixing in the atmospheric boundary layer.

Analysis of the two morning runs (Sehmel, 1982) showed a number of interesting results:

1) The tracer plume was generally very narrow under the stable atmospheric conditions encountered during the early morning. Mixing with ambient air was very limited.

2) Analysis of the tracer plume showed that the early morning surface drainage winds followed the terrain very closely, tending to remain within a shallow gulch rather than spreading out across the terrain. Until the gulches merged, there was little interaction between the flows down adjacent gulches.

3) Farther east toward 84 Mesa (about 3 miles from the release site), the drainage flow segmented into multiple plumes as the flow followed terrain depressions into Duck and Yellow Creeks.

4) Within an hour after sunrise, the ambient tracer gas concentrations had decreased by at least an order of magnitude, indicating considerable spread and dilution of the tracer plume by the surface winds. By mid-morning, improved mixing in the boundary layers had reduced the tracer concentrations down to background levels.

This study has provided some quantitative data which may be used in the future to validate models applied to low level releases. In addition, a qualitative review of the results has shown that low level releases of $SF_6$ under nocturnal drainage wind conditions (expected to be one of the worst cases) do indeed produce high concentrations of tracer gas. The plumes undergo little dilution and mixing with ambient air, and follow the terrain features very closely.

Shortly after sunrise, the drainage flow regime is disrupted by surface heating, as shown by greatly decreased ambient concentrations of tracer gas. Worst case conditions would therefore typically be expected to occur before sunrise.

B. Meteorological Upper Air Study at Tract C-a

1. Objectives

Accurate modeling of air quality impacts, especially on a regional scale, requires a better knowledge than we currently possess of the structure of the wind field involved in transporting and dispersing the emissions in complex terrain. A short term study of the upper level winds as a step in this direction was a cooperative effort between Rio Blanco and the Atmospheric Turbulence and Diffusion Laboratory (ATDL) of the National Oceanic and Atmospheric Administration.

The major objective of the study was to measure the upper air meteorology important on a regional scale, which is not typically monitored on a routine basis. The short time period of this study (2-1/2 weeks) meant

that the results could only be interpreted as a survey. Nocturnal measurements were emphasized, since worst case air quality impacts are likely to occur during stable nighttime atmospheric conditions. Although not a definitive study, the results should be useful in answering some preliminary questions and allow future studies to be better defined.

## 2. Methods

The ATDL group was part of the Atmospheric Sciences in Complex Terrain (ASCOT) program, which was conducting a multi-laboratory upper air meteorology survey concentrating in the Roan Creek area (in the Southern Piceance Basin) during the period July 28 - August 6, 1982. The ATDL group had two instrument packages that were capable of measuring wind speed, wind direction, temperature, and the mixing ratio (ratio of the mass of water vapor to dry air) of air above the ground surface. Each instrument package consisted of a tethersonde, an airsonde, and associated instrumentation. The tethersonde, a helium-filled, tethered balloon with an instrument pod hanging underneath, can reach altitudes up to 1 kilometer and is capable of excellent resolution within this layer. The airsonde, a helium-filled, free-rising balloon also carrying an instrument pod, is capable of meteorological measurements up to 10 kilometers. Both instruments send data by radio to a ground station, which interprets the data and stores it on tape cassettes. With these two complimentary instruments, an excellent picture of the atmospheric boundary layer can be obtained.

The ATDL group agreed to bring two sets of these instrument packages out to Tract C-a one week prior to the start of the ASCOT program (July 20-27). For that week, both packages would be operated simultaneously at two locations near Tract C-a. The locations chosen were the ridge just to the north of the tract (at the site proposed for the Lurgi Demonstration Project) and Meteorological Monitoring Site 3 (in a gulch just east of the tract). When the ASCOT program began on July 28, one instrument package was taken down to the Roan Creek area, while the other package was moved to Meteorological Monitoring Site 2 (located on a ridge just southwest of the

tract). At least one set of instruments was operating near Tract C-a for the entire study period.

## 3. Results and Discussion

At this point, the results can only be discussed in general, since final data processing has not yet been completed. Unfortunately, the study was hampered by an unusual amount of bad weather. Thunderstorms, rain, and high winds occurred throughout the study, forcing delay or cancellation of data collection periods. Table 6-24 provides a brief chronology of the study; most experiments began in the early evening and continued through the night until sometime after sunrise.

One of the primary phenomena which this study was designed to investigate was the deep easterly wind regime which had been observed earlier near Tract C-a (Barr and Clements, 1981). If this easterly wind, which was measured within 100-200 meters of the surface, is a significant factor in the regional wind field, major changes would result in the predicted regional air quality impacts from oil shale development. The authors of this earlier study point out that this easterly wind was not found by the National Weather Service upper air station located at Grand Junction. Therefore, it must be a uniquely regional phenomenon, on the scale of the Piceance Creek Basin.

Preliminary analysis of the unpublished data at Site 2 showed that the night of July 30 and 31 most closely approximated the experimental conditions of fair weather and light winds which Barr and Clements (1981) encountered. The data from this night show a strikingly similar meteorological pattern. Figure 6-11 is a representative plot from a tethersonde sounding of wind direction, wind speed, mixing ratio, and potential temperature early on the morning of July 31. Light surface nocturnal drainage winds (westerly) were present within the lowest 50 meters, above which lies a deep layer of light easterly winds extending to at least 600 meters above ground surface (the limit of the tethersonde sounding). Figure 6-12 is a plot of a complimentary airsonde sounding

Table 6-24. Summary of Upper Air Data Taken in July and August, 1982 Near Tract C-a.

| Date | Comments |
|---|---|
| **First Week - both NOAA instrument packages set up near the tract (at Lurgi site and Site 3)** | |
| July 20/21 | Weather good, but instrumentation problems. Both airsonde systems had timer cutoff circuits that malfunctioned, causing data loss. Site 3 tethersonde worked well, but winch for tethersonde at Lurgi site failed. |
| July 21/22 | Instrumentation problems corrected, but weather was bad. Some data were collected, but high winds, rain, and lightning prevent data from being representative of nocturnal, stable conditions. |
| July 23/24 | Bad weather prevented data from being collected during most of the night. Early evening data collection aborted until 0400 hours due to thunderstorm. |
| **ASCOT Program - One NOAA instrument package set up at Met 2 Site** | |
| July 28/29 | Instrumentation problems - ground station quit early in evening, prevented any data from being collected. |
| July 30/31 | Both instrumentation and weather cooperated, best data collection of the study. Clear skies and light winds. |
| August 3/4 | Although instrumentation worked well, it was a windy night, so conditions were considerably different than previous study night. |
| August 6 | System worked well (data collection started at 0200), winds light to moderate. |

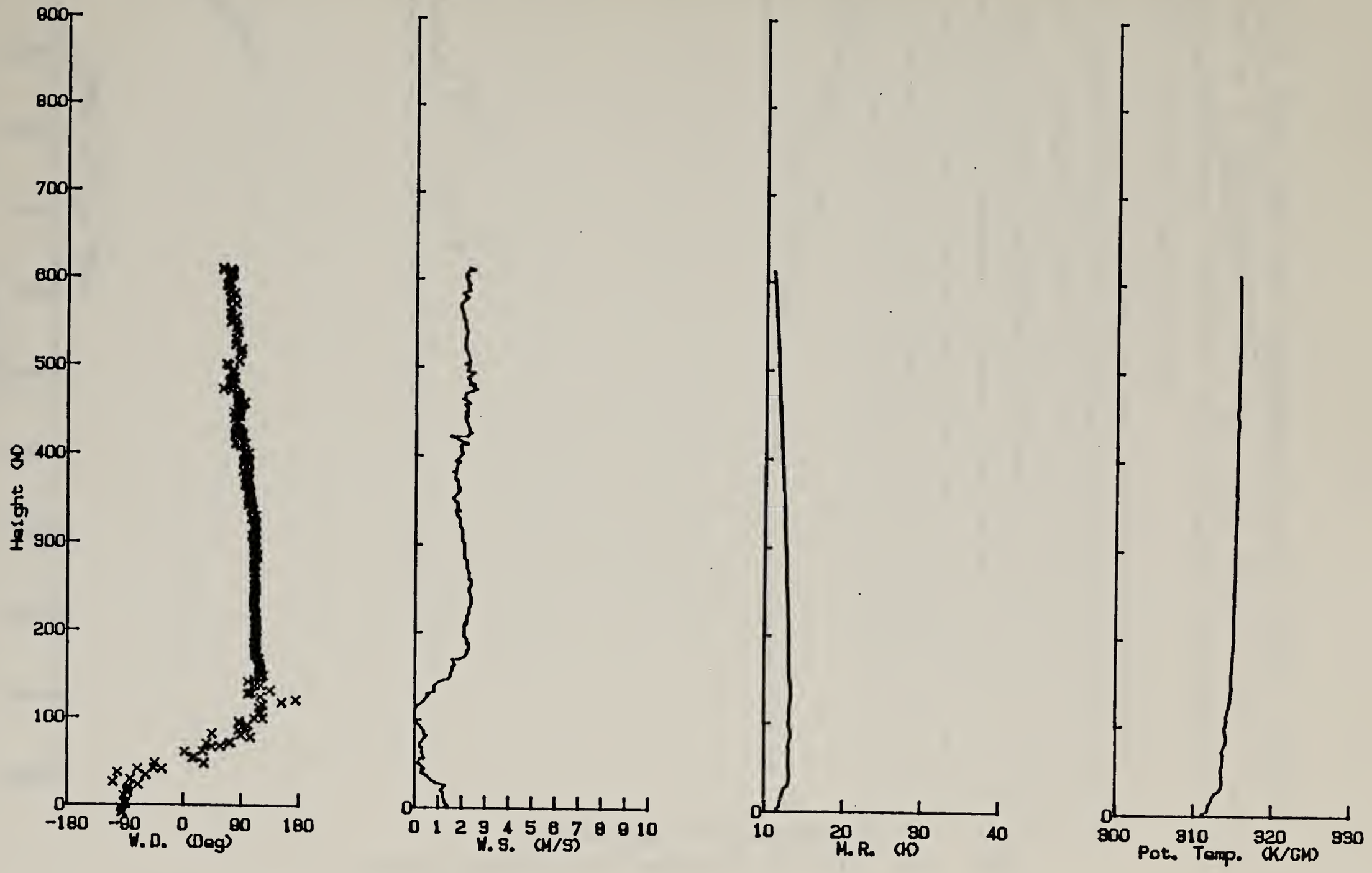



Figure 6-11. Tethersonde Sounding at Site 2

Airsonde (ATDL) at Rio Blanco Met Site 2

From 0400 MST to 450 MST on July 31, 1982

(From 500 to 550 MDT)

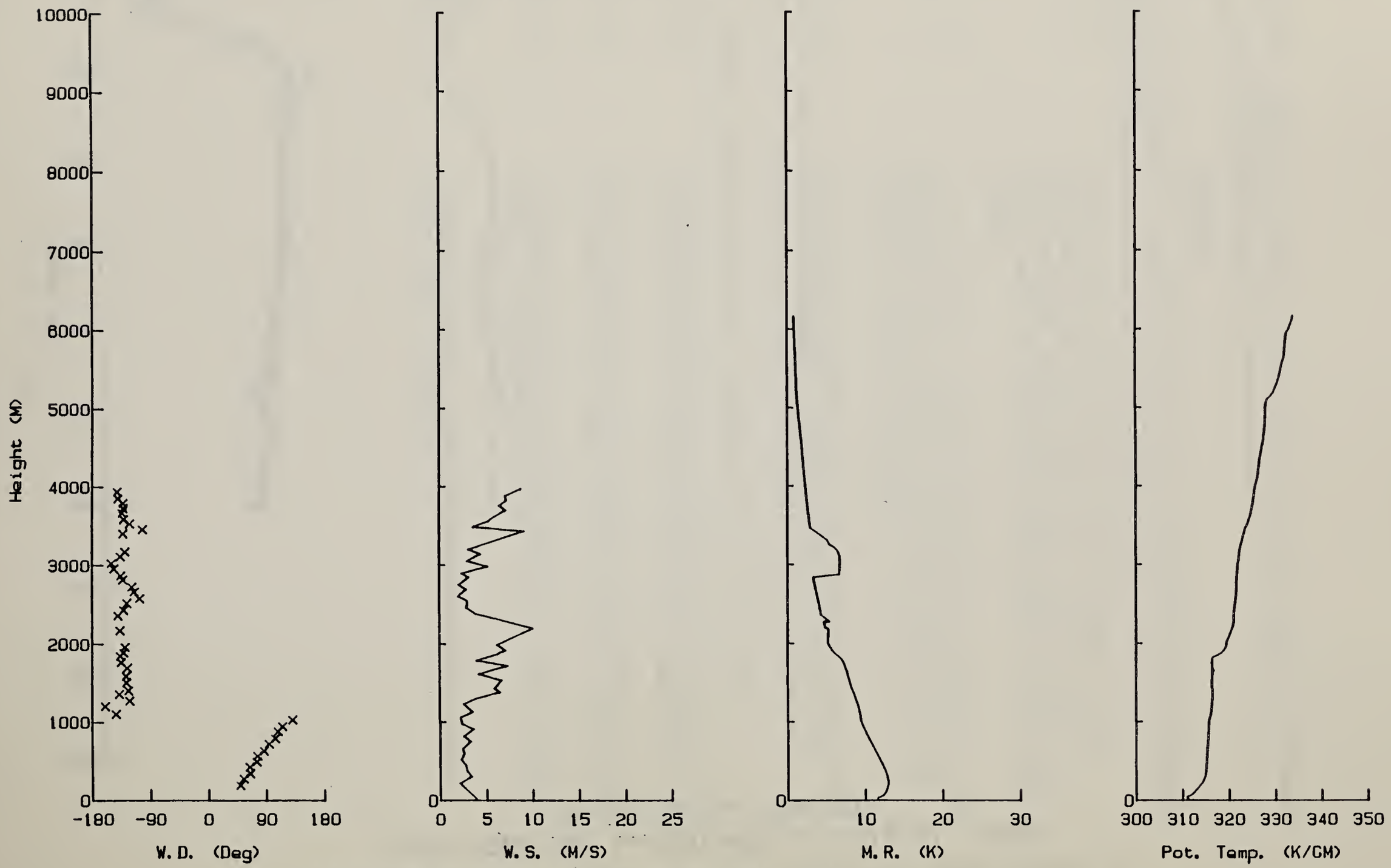



**Figure 6-12. Airsonde Sounding at Site 2**

taken two hours after the tethersonde sounding, showing atmospheric conditions up to 4,000 meters. This figure shows that the easterly wind extends to approximately 1000 meters above the surface, above which lie the conventional upper level westerly winds.

A more complete analysis will be done when the processing of these data is completed. It should be noted that short-term studies such as discussed here cannot be used to determine the frequency or extent of a potentially important wind field phenomenon. However, the finding of easterly winds in two separate studies indicates that further work and research is warranted. This is especially true in this situation, since this unusual wind pattern may have a significant effect on regional air quality impacts in and around the Piceance Basin.

## 6.7 COMPARISON STUDY OF INHALABLE AND TOTAL SUSPENDED PARTICULATES

### 1. Objectives

Many investigations have shown that the current Total Suspended Particulate (TSP) standard does not directly address health-related concerns. The major reason for this is that particles collected by TSP monitors have diameters up to a maximum of approximately 30-50 μm, whereas particles with diameters larger than 10 to 15 μm are excluded from the body by natural defense mechanisms in the respiratory system. At the same time, the larger particles have an inordinately large influence on a gravimetric sampling technique such as used for TSP, since the mass of a particle is generally proportional to the third power of the radius of a particle.

As a result, EPA is currently in the process of changing the present TSP standard to a more health-related inhalable particulate standard. The new standard will probably have a 50 percent particle cutpoint (or rejection point) at 10 μm, and will be referred to as $PM_{10}$ monitors (for Particulate Matter, 10 μm or less).

In order to determine the impact of a possible new standard on our permitting activities, and to be able to intelligently comment on any proposed regulation, $PM_{10}$ samplers were installed at the existing sites toward the end of 1982.

### 2. Methods

One $PM_{10}$ monitor was installed colocated with each of the existing TSP monitors at Sites 1 and 3. These $PM_{10}$ samplers are standard Hi-Vol monitors modified with a Wedding $PM_{10}$ inlet. The $PM_{10}$ monitors became operational on August 28, 1982.

## 3. Results and Discussion

The $PM_{10}$ monitoring program began in very late summer. This meant that the monitoring in 1982 missed the highest TSP concentrations, which are typically found before late August. In addition, September was an exceptionally wet month in 1982 (4 inches of precipitation vs. less than 2 inches in 1980 and 1981), which resulted in lower than average TSP values. Finally, startup problems with the Site 1 $PM_{10}$ sampler caused a data loss from mid-September to mid-October.

Table 6-25 presents the data collected by the $PM_{10}$ and TSP colocated monitors during 1982, in order of decreasing TSP concentrations. The ratio of $PM_{10}$ to TSP concentrations, when TSP is greater than 10 $\mu g/m^3$ (to avoid monitoring anomalies occurring under conditions of low particle loading in the atmosphere), averaged 0.61 at Site 1 and 0.58 at Site 3. This is very similar to the ratio of 0.55 assumed by EPA in developing the new $PM_{10}$ standard (Bureau of National Affairs, 1982).

However, it should be emphasized that the data collected to date comprise a relatively small sample, strongly biased toward low concentrations of particles. By the fall of 1983, a more extensive data set better representative of conditions near Tract C-a should be available for analysis.

Table 6-25. Comparison of $PM_{10}$ and TSP Data at Sites 1 and 3, August 28 - December 31, 1982.

| Site 1 | | | | Site 3 | | | |
|---|---|---|---|---|---|---|---|
| Date | TSP ($ug/m^3$) | $PM_{10}$ ($ug/m^3$) | $PM_{10}$ TSP | Date | TSP ($ug/m^3$) | $PM_{10}$ ($ug/m^3$) | $PM_{10}$ TSP |
| 08/28 | 27 | 12 | 0.44 | 09/03 | 32 | 20 | 0.63 |
| 09/03 | 20 | 11 | 0.55 | 08/28 | 27 | 13 | 0.48 |
| 10/18 | 19 | 14 | 0.74 | 08/31 | 24 | 14 | 0.58 |
| 11/08 | 15 | 10 | 0.67 | 09/09 | 23 | 14 | 0.61 |
| 09/06 | 14 | 8 | 0.57 | 10/18 | 22 | 14 | 0.64 |
| 09/09 | 14 | 7 | 0.50 | 11/05 | 21 | 12 | 0.57 |
| 08/31 | 13 | 8 | 0.62 | 09/24 | 18 | 10 | 0.56 |
| 10/24 | 13 | 9 | 0.69 | 11/08 | 17 | 11 | 0.65 |
| 10/21 | 12 | 8 | 0.67 | 09/06 | 15 | 10 | 0.67 |
| 12/11 | 11 | 8 | 0.73 | 10/21 | 12 | 6 | 0.50 |
| 11/05 | 11 | 7 | 0.64 | 09/12 | 11 | 6 | 0.55 |
| 12/08 | 11 | 5 | 0.46 | 09/21 | 11 | 6 | 0.55 |
| 11/17 | 10 | 7 | 0.70 | 10/03 | 11 | 6 | 0.55 |
| 11/26 | 10 | 7 | 0.70 | 09/15 | 10 | 6 | 0.60 |
| 10/30 | 7 | 5 | 0.71 | 09/18 | 10 | 5 | 0.50 |
| 11/02 | 7 | 4 | 0.57 | 12/17 | 9 | 5 | 0.56 |
| 12/29 | 7 | 3 | 0.43 | 10/15 | 9 | 3 | 0.33 |
| 11/23 | 6 | 3 | 0.50 | 11/17 | 8 | 5 | 0.62 |
| 12/26 | 6 | 2 | 0.33 | 10/30 | 7 | 5 | 0.71 |
| 12/14 | 6 | 1 | 0.17 | 11/26 | 7 | 4 | 0.57 |
| 11/14 | 5 | 3 | 0.60 | 11/11 | 6 | 6 | 1.00 |
| 11/29 | 5 | 2 | 0.40 | 10/12 | 6 | 3 | 0.50 |
| 10/27 | 3 | 2 | 0.67 | 10/09 | 5 | 6 | 1.20 |
| 11/20 | 2 | 1 | 0.50 | 11/02 | 5 | 2 | 0.40 |
| 12/05 | 2 | 0 | -- | 11/29 | 5 | 2 | 0.40 |
| 12/20 | 1 | 0 | -- | 11/14 | 4 | 2 | 0.50 |
| | | | | 11/23 | 4 | 1 | 0.25 |
| | | | | 10/06 | 3 | 2 | 0.67 |
| | | | | 11/20 | 3 | 1 | 0.33 |
| | | | | 12/23 | 3 | 1 | 0.33 |
| | | | | 12/26 | 3 | 1 | 0.33 |
| | | | | 12/29 | 3 | 1 | 0.33 |
| | | | | 10/27 | 2 | 1 | 0.50 |
| | | | | 12/02 | 2 | 0 | -- |
| | | | | 12/05 | 1 | 0 | -- |

## 6.8 Yellow Creek Stream Classification Study

### 1. Objectives

In 1978 the Colorado Water Quality Control Commission (WQCC) was authorized by the EPA to establish and monitor a set of stream use classifications and water quality standards for all waters in the State of Colorado. This authorization was granted under provisions of the Clean Water Act. During 1982 the State Department of Health Water Quality Control Division, proposed a set of stream use classifications and water quality standards for pre-established segments of the Lower Colorado, Yampa, and White River drainage systems. These classifications and standards were the subject of a public hearing which commenced in October 1982.

Segments 12 and 13 of the White River Drainage System were defined as follows:

Segment 12: The main stream of the White River from the mouth of Piceance Creek to the mouth of Douglas Creek.

Segment 13: All tributaries to the White River from the mouth of Piceance Creek to the mouth of Douglas Creek.

Figure 6-13 shows most of the tributaries defined in segment 13 and the majority of segment 12. Rio Blanco's Tract C-a overlaps several of the minor tributaries in segment 13. These tributaries feed into Yellow Creek, the major drainage for this portion of the Piceance Basin.

The primary objectives of the Yellow Creek Stream Classification study were to:

A. Evaluate the Yellow Creek drainage system physical conditions during the spring runoff and dry seasons.

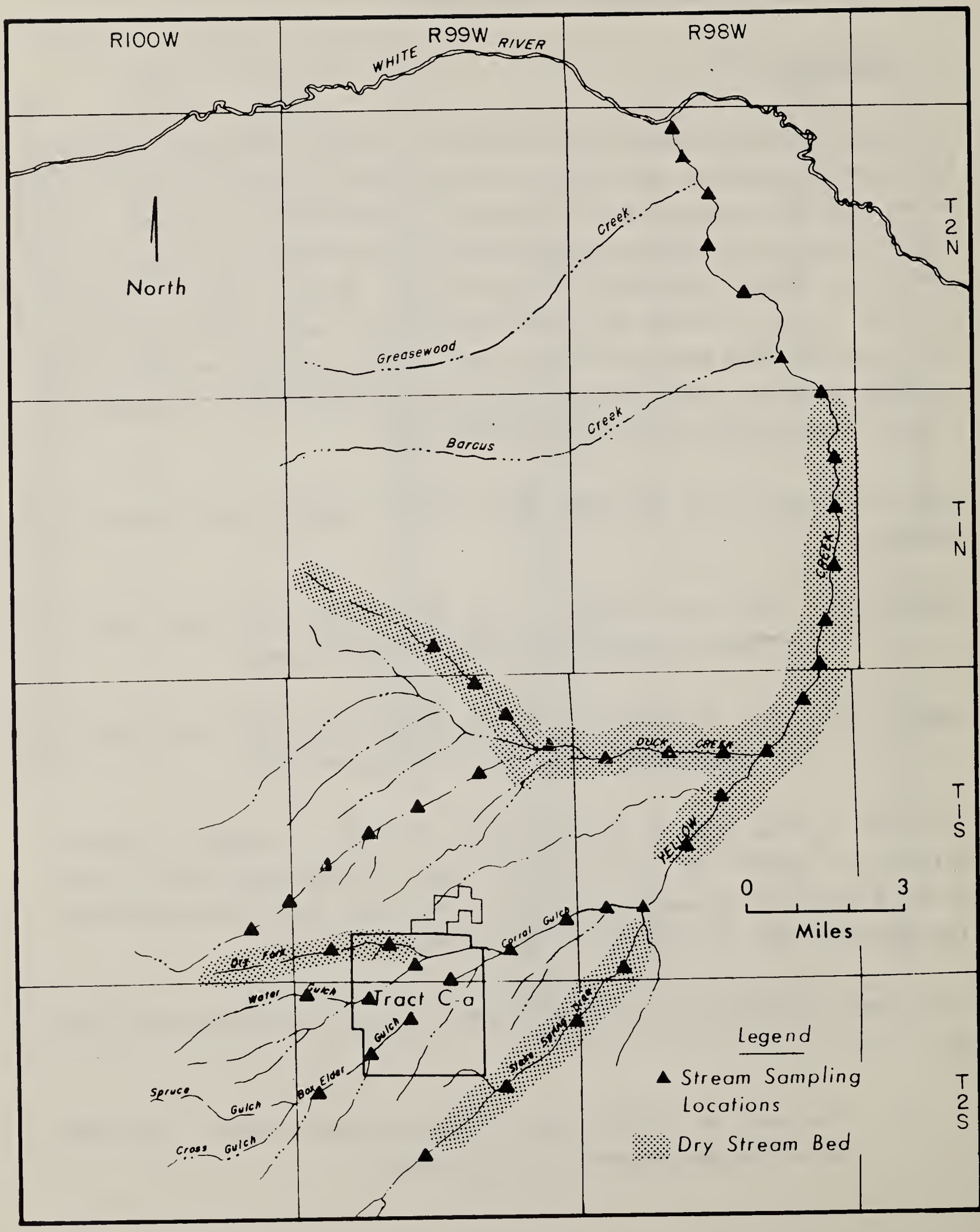



Figure 6-13. Stream Segments 12 and 13 in the Lower Colorado Basin, White River Drainage System.

B. Collect aquatic characterization data for the drainage system to support Rio Blanco's position in the public hearings.

C. Establish a data base on the Yellow Creek drainage system for use in future planning.

## 2. Methods

United States Geological Survey topographic maps for the Yellow Creek drainage system were segmented by stream mile (Figure 6-13). The confluence of tributaries was the start of a new segment (e.g. the confluence of Corral Gulch and Yellow Creek was station CG000, Corral Gulch mile 00.0).

Measurements made were those physical and habitat characteristics which would contribute to an evaluation of aquatic habitat potential, and which would be affected by seasonal and/or other natural conditions. Table 6-26 presents a list of the physical measurements and habitat characteristics that were evaluated. These measurements are consistent with those used by the Canadian Ministry of Natural Resources and the USDI Fish and Wildlife Service Stream Assessment Group (Bovee and Milhous 1978; Dodge et al. 1981).

Sampling was conducted at each mile increment of the drainage basin. A total of 58 miles (stations) were sampled in April 1982, and 53 miles (stations) were sampled in August 1982. April and August were chosen as sampling times because they represent the spring runoff period (April) and the dry season (August). Each of the measurements described in Table 6-26 were made at each station where surface flow was evident. In April, upstream and a downstream photographs were taken, and in August, an upstream photograph was taken to create a permanent record of the sampling.

## 3. Results and Discussion

A comparison of the physical and habitat characteristics was made to provide a physical profile of the Yellow Creek Drainage System. Several patterns were found and are discussed below.

Table 6-26. Measurements made during the Yellow Creek Stream Survey, April & August 1982.

| Parameter | Instrument/Description |
|---|---|
| **Physical Measurements (Field Water Quality)** | |
| Water Temperature | YSI Probe |
| Conductivity | Myron L Company |
| Dissolved Oxygen | YSI Probe |
| pH | Myron L. Company |
| Flow (velocity) | Gurly Flow Meter |
| Visual Turbidity | Observation (Visual) |
| Stream Width | Measurement Tape |
| **Habitat Characteristics Observations** | |
| Substrate Composition Index | A visual estimate of the silting and substrate composition within 20 meters of the site. |
| Flow During Survey Index | An examination of the type of flow being recorded (flooding, high, medium, low, etc.) |
| Bank Vegetation Rating | A visual estimate of the amount of vegetation being used to provide canopy cover directly over stream. |
| Bank Condition Rating | An estimate of the amount of use by man and/or livestock and wildlife on the stream banks. |
| Stream Channel Stability | The amount of scouring and stream bed erosion taking place. |
| Stream Channel Condition | An estimate of the amount of use by man or livestock and wildlife in the stream bed. |

Probably the single most dominant characteristic documented in this survey is intermittent flow. During the runoff season in April, 34 of the 58 stations (58.6%) were dry stream beds, while in August, 29 of 53 stations (54.7%) were dry. The majority of the dry stations were found in the middle of the drainage system. Stations near the confluence of Yellow Creek with the White River and stations between Cathedral Bluffs and Tract C-a were generally wet with measureable flow in both April and August. Table 6-27 shows the distribution of dry stations, in several tributaries, sampled in this survey. All stations that were dry in both sampling periods all had a correspondingly high density of sagebrush in the stream channel, while the wet stations had no sagebrush in the stream bed and very little on the embankments, except at stations with highly incised channels, where the embankment height was 5-10 feet. This may indicate that the water table may be well below the stream bed surface in the alluvium.

Flow was calculated at each station where an accurate Gurly meter velocity reading could be obtained. Table 6-28 shows the average flow measured during the two sampling periods. The highest flow (0.05 $m^3$/sec) was recorded in April at mile marker 3 on Yellow Creek, just below the confluence with Barcus Creek, while the lowest measureable flow in the drainage was recorded in August at mile marker 10 in Big Duck Creek (0.0002 $m^3$/sec), near the head waters adjacent to Cathedral Bluffs. Measureable flow was intermittent throughout the entire drainage system. A large portion of the stations with measureable flow were concentrated either west of Tract C-a or near the confluence with the White River in Lower Yellow Creek.

Two stations in the predominently dry stream segments exhibited permanent flow conditions. Stations at mile marker 3 on Big Duck Creek and mile marker 13 on Yellow Creek both had measureable flow. Stations for several miles on either side of these two locations were predominantly dry with indications that interimittent flow due to storm conditions exists. Both of these stations had a high percentage of riparian cover in the stream bed and very little sagebrush on the channel embankments. These habitat characteristics are expected at locations where the alluvial water is at or near the surface.

Table 6-27. Percent (%) of Dry Stream Bed During the Runoff and Dry Stream Sampling Periods.

| Drainage | No. of Stations in Drainage[1/] | % Dry April (# Stations) | % Dry August (# Stations) |
|---|---|---|---|
| Box Elder Gulch | 6 | 50 (3) | 17 (1) |
| Corral Gulch | 7 | 57 (4) | 43 (3) |
| Big Duck Creek | 11 | 73 (8) | 64(7) |
| Dry Fork Gulch | 2 | 100 (2) | 100 (2) |
| Little Duck Creek | 3 | 100 (3) | ... |
| Stake Springs Draw | 6 | 83 (5) | 83 (5) |
| Yellow Creek | 19 | 47 (9) | 58 (11) |

1/ No. of stations is also the number of stream bed miles that were sampled. Water Gulch data is not included in this table; this tributory had permanent flow in both seasons.

... Unable to sample Little Duck Creek in August, due to fencing restrictions.

Table 6-28. Average flow ($m^3$/sec) for Individual Tributaries in the Yellow Creek Drainage System During the Runoff (April) and Dry (August) Stream Sampling Periods.

| | APRIL | | AUGUST | |
|---|---|---|---|---|
| | Number of Stations Where Flow Was Measured | Average[1/] Flow ($M^3$/Sec) | Number of Stations Where Flow Was Measured | Average[1/] Flow ($M^3$/Sec) |
| Box Elder Gulch | 3 | 0.0024 | 2 | 0.0016 |
| Corral Gulch | 3 | 0.0013 | 1 | 0.0026 |
| Cottonwood Springs | 1 | 0.0010 | 1 | 0.0003 |
| Big Duck Creek | 3 | 0.0003 | 4 | 0.0014 |
| Yellow Creek | 10 | 0.0085 | 4 | 0.0173 |

1/ Average flow was based on the number of samples listed in the number of stations with measurable flow column.

Average field water quality measurements for the two sampling periods are shown in Table 6-29. Data presented in Figure 6-14 and Table 6-29 indicate that saline waters are evident in the lower portions of the Yellow Creek drainage. Conductivities in Lower Yellow Creek (miles 00 to 06) were between 2600 and 3600 micromhos per cm in the runoff season, and between 2000 and 3300 micromhos per cm in the dry season. The higher conductivities in April may be attributable to the increased flow conditions picking up salts from the stream embankments.

No consistent pattern in dissolved oxygen (D.O.) measurements was seen in the Yellow Creek drainage (Table 6-29). Figure 6-15 shows the D.O. data for the two sampling periods. The D.O. tended to be variable in the first four miles in Yellow Creek in the April sampling and very stable in the August sampling. Between Yellow Creek mile markers 6 through 8 there was an increase of 4 mg/l D.O. during both sampling seasons. These three stations are very different in there habitat characteristics which may help to explain the increase in D.O. between these sections. Mile marker 6 has high, steep embankments (8-12 feet above the stream channel) and a sagebrush canopy that shades the stream bed from much of the solar radiation. Mile marker 8 is open with little cover; thus, more solar radiation is able to reach the stream bed. Mile 6 has a large amount of filamentous algae and periphyton attached in the stream channel, while mile 8 contains little algae and has a silt free stream substrate. These changes described are gradual over a 3 mile stretch of the drainage, from mile 6 through 8. Mile marker 7 is intermediate to the habitats described above for miles 6 and 8.

Relatively stable pH conditions exist in Yellow Creek. Data presented in Figure 6-16 and Table 6-29 indicate that the mean pH for the lower portions of the drainage was 7.7 in April and 8.4 in August.

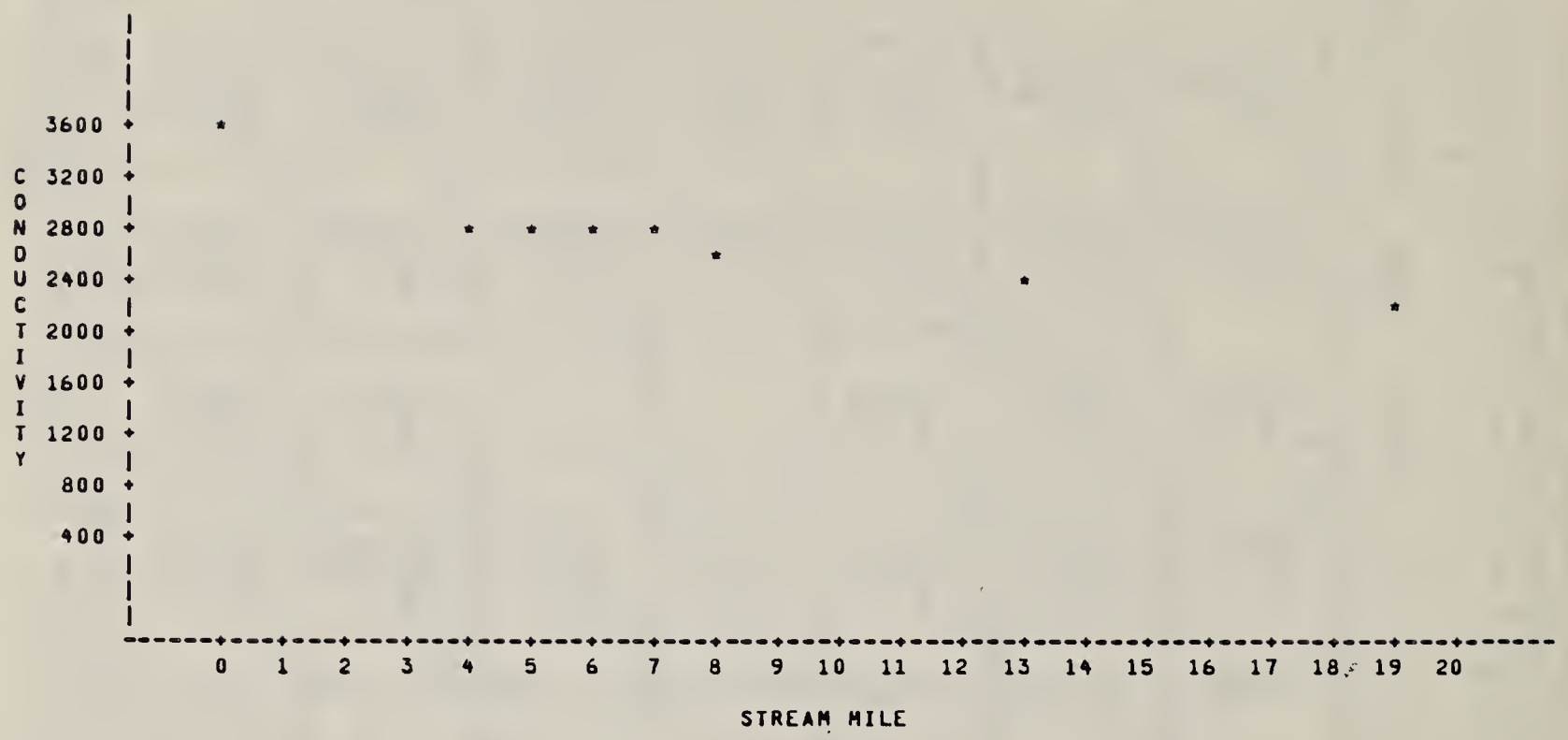
Water quality near the head waters of the Yellow Creek drainage system was substantially better than the middle and lower segments of the drainage. Data presented in Table 6-29 indicate lower conductivities, slightly alkaline pH's (8 to 9 S.U.) and dissolved oxygen readings between 5 and

Table 6-29. Mean Field Water Quality (FWQ) Measurements for each Tributary in the Yellow Creek Drainage System, During the spring runoff (April) and dry season (August).

| VARIABLE | N | MEAN | STANDARD DEVIATION | MINIMUM VALUE | MAXIMUM VALUE | STD ERROR OF MEAN |
|---|---|---|---|---|---|---|
| ---------- ORAINAGE=BOX ELDER GULCH SEASON=ORY SEASON - AUGUST ---------- | | | | | | |
| TEMP1 | 4 | 21.6 | 8.9 | 8.3 | 27.5 | 4.5 |
| CONO1 | 4 | 1050.0 | 91.3 | 950.0 | 1150.0 | 45.6 |
| OOXY1 | 4 | 5.1 | 0.5 | 4.6 | 5.8 | 0.3 |
| PH1 | 4 | 8.1 | 0.5 | 7.4 | 8.5 | 0.2 |
| WIDTH | 3 | 0.8 | 0.2 | 0.7 | 1.1 | 0.1 |
| --------- ORAINAGE=BOX ELDER GULCH SEASON=PEAK RUNNOFF - APRIL ---------- | | | | | | |
| TEMP1 | 3 | 18.5 | 3.3 | 15.5 | 22.0 | 1.9 |
| CONO1 | 3 | 958.3 | 52.0 | 900.0 | 1000.0 | 30.0 |
| OOXY1 | 3 | 6.9 | 0.9 | 5.8 | 7.6 | 0.5 |
| PH1 | 3 | 8.1 | 0.2 | 7.9 | 8.2 | 0.1 |
| WIDTH | 3 | 0.5 | 0.2 | 0.3 | 0.6 | 0.1 |
| ---------- DRAINAGE=CORRAL GULCH SEASON=ORY SEASON - AUGUST ---------- | | | | | | |
| TEMP1 | 5 | 18.2 | 3.2 | 15.3 | 23.2 | 1.4 |
| CONO1 | 5 | 1346.0 | 395.1 | 980.0 | 2000.0 | 176.7 |
| OOXY1 | 5 | 6.3 | 1.1 | 5.8 | 8.2 | 0.5 |
| PH1 | 5 | 8.2 | 0.4 | 7.6 | 8.5 | 0.2 |
| WIDTH | 5 | 1.2 | 0.3 | 0.9 | 1.7 | 0.1 |
| ---------- DRAINAGE=CORRAL GULCH SEASON=PEAK RUNNOFF - APRIL ---------- | | | | | | |
| TEMP1 | 3 | 12.0 | 6.0 | 6.0 | 18.0 | 3.5 |
| CONO1 | 3 | 1583.3 | 375.3 | 1200.0 | 1950.0 | 216.7 |
| OOXY1 | 3 | 8.4 | 2.1 | 7.2 | 10.9 | 1.2 |
| PH1 | 3 | 8.1 | 0.3 | 7.8 | 8.3 | 0.1 |
| WIDTH | 2 | 0.4 | 0.1 | 0.3 | 0.4 | 0.1 |
| -------- DRAINAGE=COTTONWOOD SPRINGS SEASON=DRY SEASON - AUGUST --------- | | | | | | |
| TEMP1 | 1 | 21.4 | . | 21.4 | 21.4 | . |
| CONO1 | 1 | 1200.0 | . | 1200.0 | 1200.0 | . |
| OOXY1 | 1 | 5.8 | . | 5.8 | 5.8 | . |
| PH1 | 1 | 8.1 | . | 8.1 | 8.1 | . |
| WIDTH | 1 | 0.9 | . | 0.9 | 0.9 | . |
| -------- ORAINAGE=COTTONWOOD SPRINGS SEASON=PEAK RUNNOFF - APRIL -------- | | | | | | |
| TEMP1 | 1 | 9.5 | . | 9.5 | 9.5 | . |
| CONO1 | 1 | 1300.0 | . | 1300.0 | 1300.0 | . |
| OOXY1 | 1 | 9.0 | . | 9.0 | 9.0 | . |
| PH1 | 1 | 8.2 | . | 8.2 | 8.2 | . |
| WIDTH | 1 | 0.3 | . | 0.3 | 0.3 | . |
| ---------- ORAINAGE=BIG DUCK CREEK SEASON=ORY SEASON - AUGUST ---------- | | | | | | |
| TEMP1 | 4 | 23.5 | 1.2 | 22.0 | 24.8 | 0.6 |
| CONO1 | 4 | 1125.0 | 50.0 | 1050.0 | 1150.0 | 25.0 |
| OOXY1 | 4 | 8.1 | 1.8 | 5.6 | 9.5 | 0.9 |
| PH1 | 4 | 8.4 | 0.2 | 8.1 | 8.6 | 0.1 |
| WIDTH | 4 | 0.7 | 0.2 | 0.5 | 1.0 | 0.1 |

| VARIABLE | N | MEAN | STANDARD DEVIATION | MINIMUM VALUE | MAXIMUM VALUE | STD ERROR OF MEAN |
|---|---|---|---|---|---|---|
| ---------- DRAINAGE=BIG DUCK CREEK SEASON=PEAK RUNNOFF - APRIL ---------- | | | | | | |
| TEMP1 | 3 | 12.5 | 2.8 | 10.0 | 15.5 | 1.6 |
| CONO1 | 3 | 1450.0 | 304.1 | 1250.0 | 1800.0 | 175.6 |
| OOXY1 | 3 | 9.2 | 1.8 | 7.6 | 11.1 | 1.0 |
| PH1 | 3 | 8.0 | 0.1 | 7.9 | 8.1 | 0.1 |
| WIDTH | 3 | 0.4 | 0.1 | 0.3 | 0.5 | 0.1 |
| -------- DRAINAGE=STAKE SPRINGS DRAW SEASON=DRY SEASON - AUGUST --------- | | | | | | |
| TEMP1 | 2 | 21.8 | 4.6 | 18.5 | 25.0 | 3.3 |
| CONO1 | 2 | 1325.0 | 106.1 | 1250.0 | 1400.0 | 75.0 |
| OOXY1 | 2 | 5.0 | 2.6 | 3.2 | 6.9 | 1.8 |
| PH1 | 2 | 7.8 | 0.1 | 7.8 | 7.9 | 0.0 |
| WIDTH | 2 | 5.5 | 0.1 | 5.5 | 5.6 | 0.0 |
| -------- DRAINAGE=STAKE SPRINGS DRAW SEASON=PEAK RUNNOFF - APRIL -------- | | | | | | |
| TEMP1 | 2 | 5.3 | 2.5 | 3.5 | 7.0 | 1.8 |
| CONO1 | 2 | 1675.0 | 247.5 | 1500.0 | 1850.0 | 175.0 |
| OOXY1 | 2 | 11.3 | 1.3 | 10.4 | 12.2 | 0.9 |
| PH1 | 2 | 7.7 | 0.2 | 7.6 | 7.9 | 0.1 |
| WIDTH | 2 | 7.4 | 0.3 | 7.3 | 7.6 | 0.2 |
| ---------- ORAINAGE=WATER GULCH SEASON=DRY SEASON - AUGUST ---------- | | | | | | |
| TEMP1 | 1 | 15.2 | . | 15.2 | 15.2 | . |
| CONO1 | 1 | 880.0 | . | 880.0 | 880.0 | . |
| OOXY1 | 1 | 5.6 | . | 5.6 | 5.6 | . |
| PH1 | 1 | 7.8 | . | 7.8 | 7.8 | . |
| WIDTH | 1 | 1.1 | . | 1.1 | 1.1 | . |
| ---------- DRAINAGE=WATER GULCH SEASON=PEAK RUNNOFF - APRIL ---------- | | | | | | |
| TEMP1 | 1 | 16.0 | . | 16.0 | 16.0 | . |
| CONO1 | 1 | 1100.0 | . | 1100.0 | 1100.0 | . |
| OOXY1 | 1 | 7.0 | . | 7.0 | 7.0 | . |
| PH1 | 1 | 8.1 | . | 8.1 | 8.1 | . |
| WIDTH | 1 | 0.1 | . | 0.1 | 0.1 | . |
| ------- ORAINAGE=YELLOW CREEK DRAINAGE SEASON=DRY SEASON - AUGUST ------- | | | | | | |
| TEMP1 | 8 | 17.5 | 2.8 | 14.5 | 20.5 | 1.0 |
| CONO1 | 8 | 2730.0 | 353.8 | 2050.0 | 3150.0 | 125.1 |
| OOXY1 | 8 | 8.1 | 1.4 | 6.9 | 10.4 | 0.5 |
| PH1 | 8 | 8.4 | 0.3 | 7.8 | 8.9 | 0.1 |
| WIDTH | 7 | 2.3 | 1.2 | 0.6 | 4.2 | 0.4 |
| ------ DRAINAGE=YELLOW CREEK DRAINAGE SEASON=PEAK RUNNOFF - APRIL ------- | | | | | | |
| TEMP1 | 11 | 14.5 | 4.6 | 7.5 | 20.5 | 1.4 |
| CONO1 | 11 | 3104.5 | 638.1 | 2200.0 | 4050.0 | 192.4 |
| OOXY1 | 11 | 9.4 | 1.9 | 6.2 | 13.0 | 0.6 |
| PH1 | 11 | 7.7 | 0.5 | 7.0 | 8.3 | 0.1 |
| WIDTH | 11 | 1.0 | 0.5 | 0.3 | 1.8 | 0.2 |

Temp1= Water Temperature (°c) Cond1= Conductivity (micromhos/cm) Doxy1= Dissolved Oxygen (mg/l) pH1= pH (SU) Width= Stream Width (Meters)



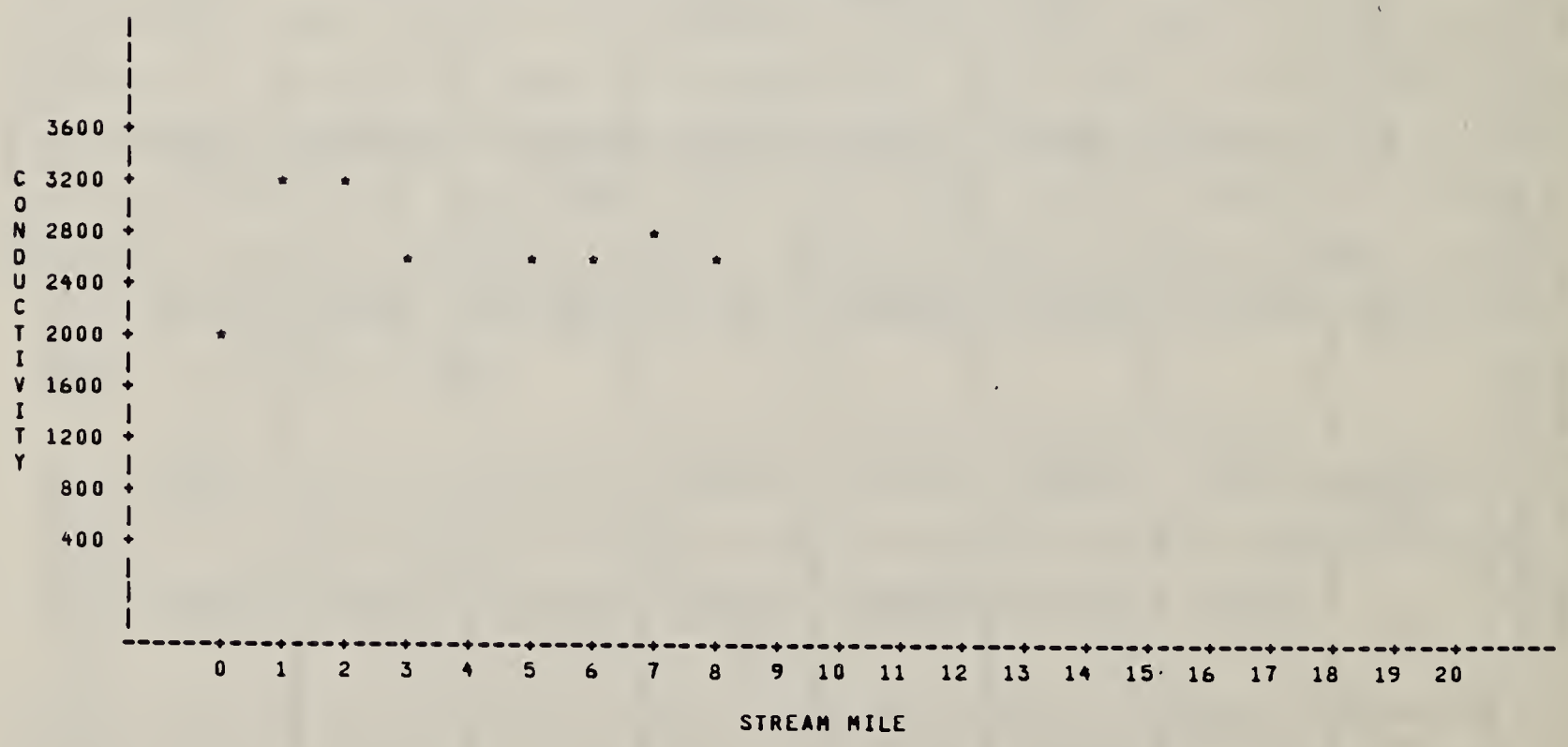
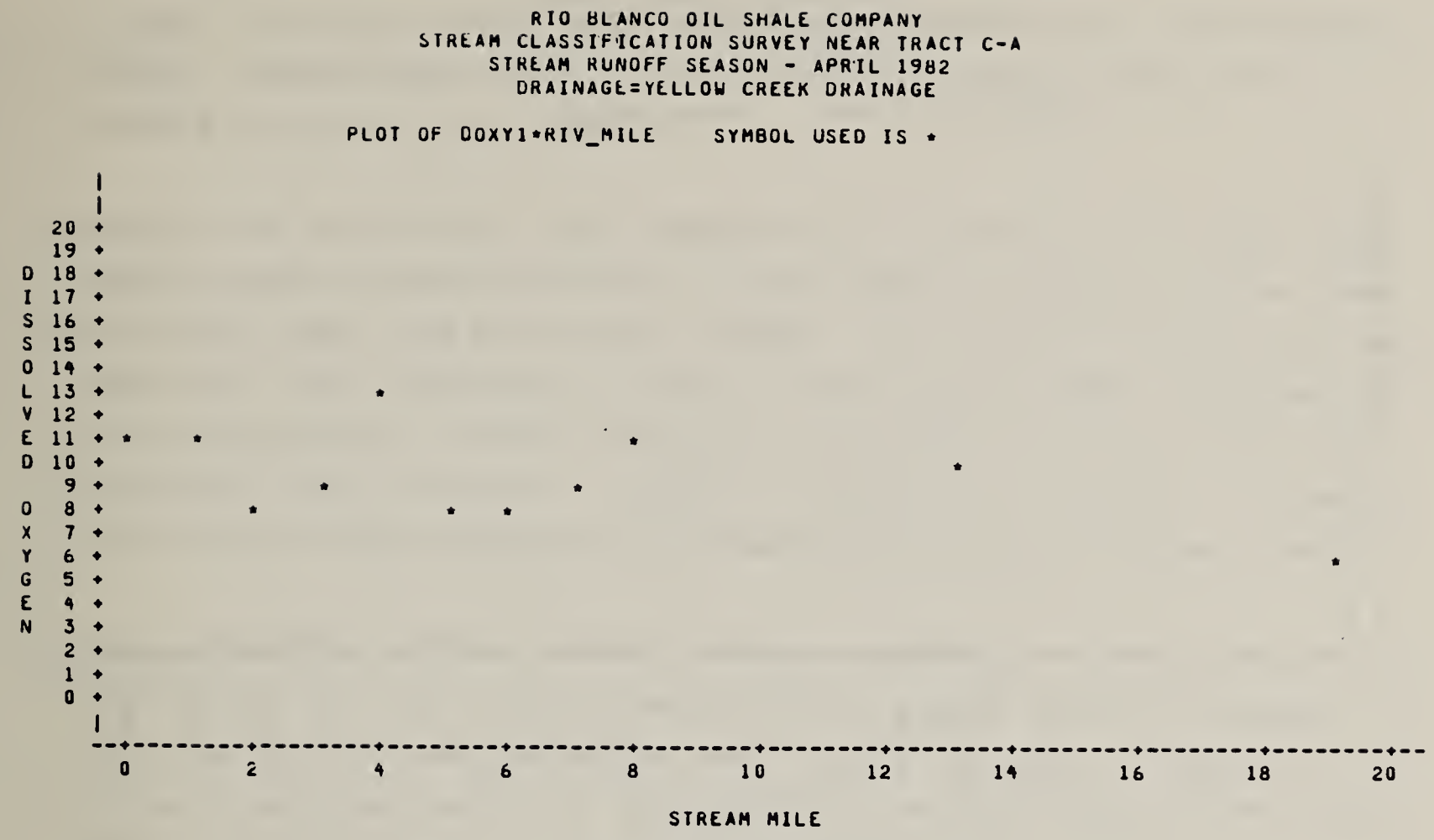




Figure 6-14. Conductivity Measurements (micromhos/cm) made on Yellow Creek During the Runoff and Dry Stream Seasons (April and August 1982).



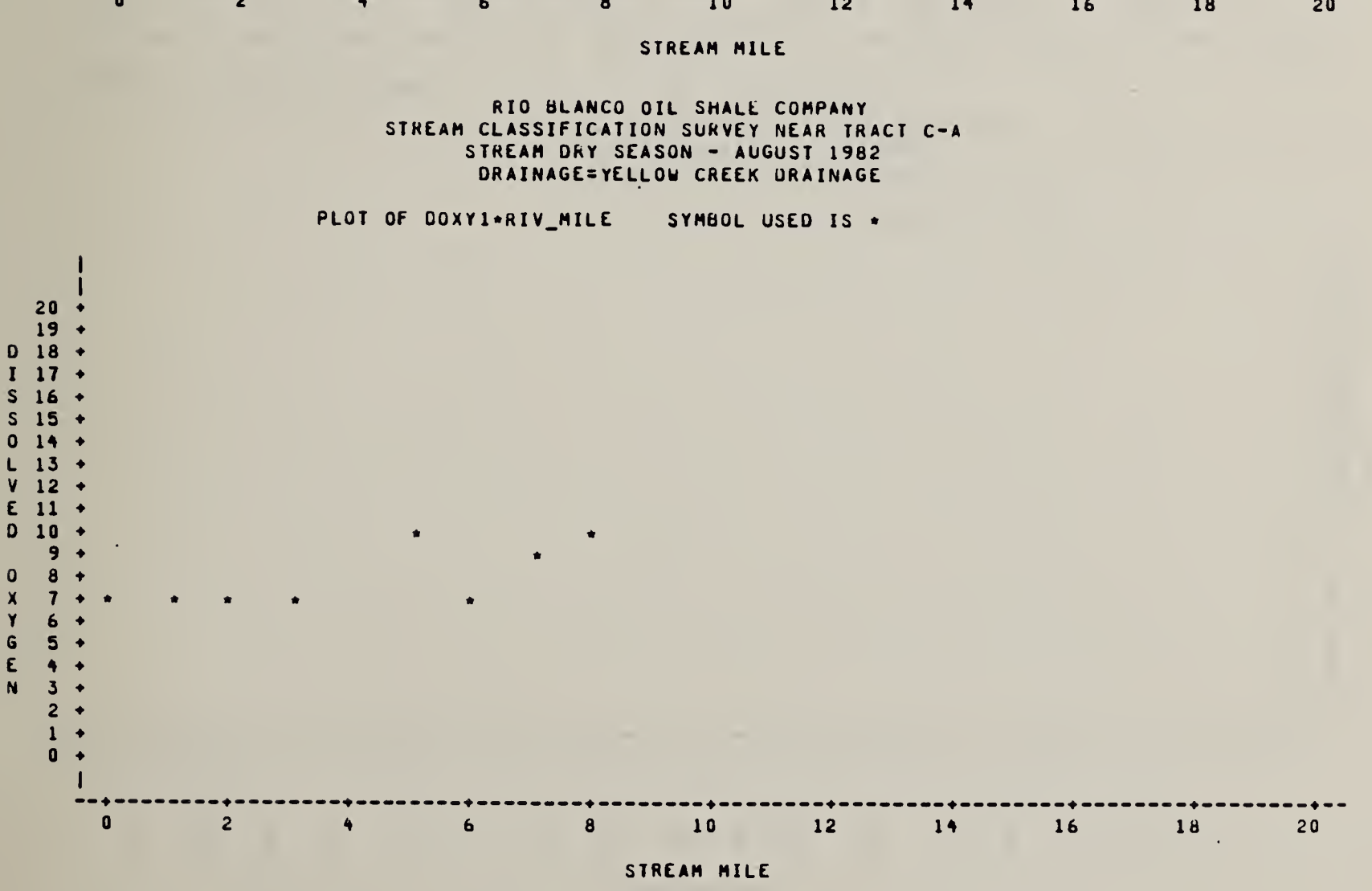
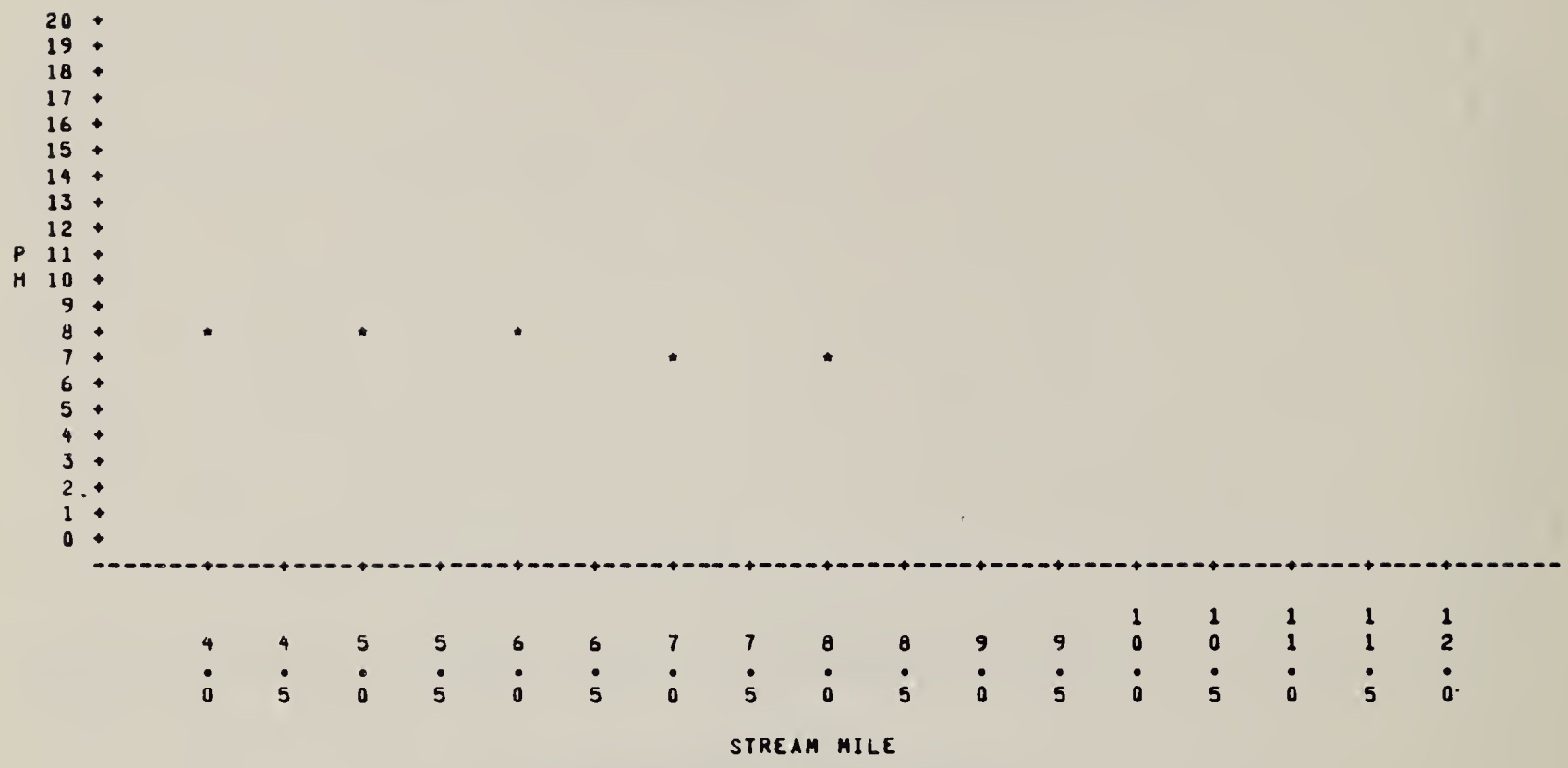




Figure 6-15. Dissolved Oxygen Measurements (mg/l) made on Yellow Creek, During the Runoff and Dry Seasons (April and August 1982).

RIO BLANCO OIL SHALE COMPANY
STREAM CLASSIFICATION SURVEY NEAR TRACT C-A
STREAM RUNOFF SEASON - APRIL 1982
DRAINAGE=YELLOW CREEK DRAINAGE

PLOT OF PH1*RIV_MILE SYMBOL USED IS *




RIO BLANCO OIL SHALE COMPANY
STREAM CLASSIFICATION SURVEY NEAR TRACT C-A
STREAM DRY SEASON - AUGUST 1982
DRAINAGE=YELLOW CREEK DRAINAGE

PLOT OF PH1*RIV_MILE SYMBOL USED IS *

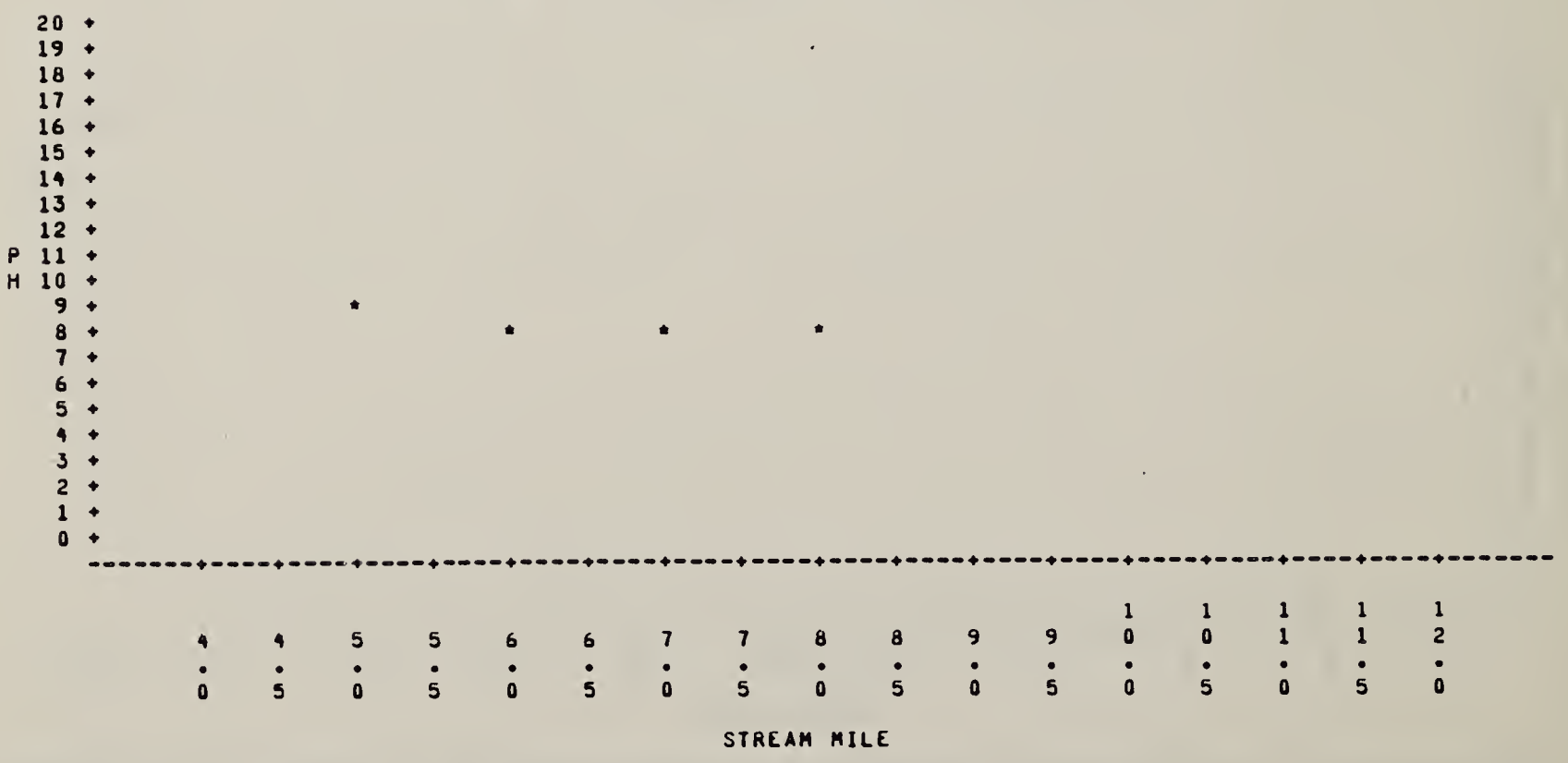



Figure 6-16. PH Measurements (S.U.) made on Yellow Creek, During the Runoff and Dry Seasons (April and August 1982).

11 mg/l in Corral Gulch, Water Gulch, Box Elder Gulch, and Cottonwood Springs. Lower Yellow Creek is characterized by higher conductivities and variable pH and dissolved oxygen.

Results of this survey were presented to the State of Colorado Water Quality Control Commission (WQCC) in their public hearings for the Lower Colorado, Yampa, and White River systems. As a result of these data and additional data collected as part of the ongoing RBOSC environmental monitoring program, the WQCC adopted an agriculture use classification for the Yellow Creek drainage. No numeric standards were placed on segment 13(b) (Yellow Creek) because of the intermittent nature of the water source.

These standards and use classifications accurately reflect the stream conditions in the Yellow Creek Basin. Aquatic life is limited to macroinvertebrates and periphyton when flow is present. There are no stream recreational uses (e.g. trout fishing, rafting, etc.) in the Yellow Creek drainage system.

## 6.9 TOXICOLOGY

In late 1980, the toxicology testing program outlined in RBOSC (1982) was developed. At that time, Rio Blanco was completing the experimental modified-in situ (MIS) program and was pursuing a "fast-track" program including a Lurgi demonstration project followed by full commercial development. The initial program was modified to some extent as development plans were modified.

Present testing (subchronic inhalation and inhalation reproduction tests) is oriented to worker protection at the PDU (pilot plant).

Toxicology testing results to-date on Lurgi and MIS materials are as follows:

- None of the samples of shale oil, shale process emissions, or raw or spent shale produced significant toxicity when administered as single doses either orally or by skin contact. Light and middle Lurgi shale oil were slightly toxic in oral exposure (median lethal doses ranging from 2.7 to 4.9 g/kg), with females generally being somewhat more susceptible than males.

- The four shale oil samples were all minimally irritating to the eye, with no detectable differences between them in this regard. The sour water samples produced no reactions, and the spent shale was found to be mildly irritating. This latter finding is interpreted as a response to mechanical irritation and not to any attribute of the shale material itself.

- The shale oil materials stain the skin, making it difficult to apply conventional criteria used to evaluate dermal irritation in animal studies. However, the findings suggest that shale oils are mildly irritating under conditions of prolonged intimate contact with the skin. Under the same conditions of testing, the various sour water samples were found to be minimally irritating to slightly irritating to the skin.

- Light Lurgi Shale Oil vapor is essentially nontoxic in acute inhalation exposure.

- All four shale oil samples were mutagenic in the Unscheduled DNA Synthesis assay, and all three Lurgi oil samples were mutagenic in the Forward Mutation assay. Of the four shale oil samples tested, only the Middle Lurgi Shale Oil was positive in the Ames test. All mutagenicity tests run on the sour water samples and the raw and spent shale samples were negative.

- Preliminary dose-ranging studies with pregnant and nonpregnant test animals indicated that repeated dermal applications of shale oil resulted in body weight loss, but there was no indication of interference with pregnancy or with survival of offspring.

- All of the materials tested produced changes in the mitotic index in cytogenetic studies, but these changes were inconsistent with dose both in direction and magnitude. The incidence of polyploid cells was significantly increased in animals treated with Light Lurgi Shale Oil, but none of the materials tested produced any indication of an increased tendency toward aberrant chromosomes.

## 6.10 SUMMARY

### A. Revegetation

#### 1. Experimental Revegetation on Surface Disturbed Sites

Experimental revegetation Plot R-1, located on a northwestern exposure at 2164 M (7100 ft), had an average vegetative cover of 49.5 percent over the sixteen treatment combinations tested. Planted grasses accounted for 43 percent of this average. Although wheatgrass (Agropyron) species continued to be the most abundant planted grass species, green needlegrass (Stipa viridula) and Indian ricegrass (Oryzopsis hymenoides) were encountered frequently. There were no significant differences in the cover of planted or invaded grasses based on either mulch or fertilizer treatments during 1982. However, there were significant differences among years. Cover of planted grass species during 1982 was significantly higher than that of all other sample periods except 1981.

Cover of planted forb species averaged 15.9 percent during 1982, or approximately 32 percent of the total cover averaged over all treatments. The most prevalent planted forb species continued to be Lewis flax (Linum lewisii), yellow sweetclover (Melilotus officinalis) and cicer milkvetch (Astragalus cicer). Invaded forb species accounted for an average of 3.3 percent cover, resultant in large part from scarlet gilia (Ipomopsis aggregata), Douglas chaenactis (Chaenactis douglasii), Cryptantha sericea and Machaeranthera species. Significant differences were noted among blocks for planted forbs and among mulch treatments for invaded forbs during 1982. When data for all years were compared, it appeared that forbs were favored by hydromulch more so than by either of the straw mulch treatments. Comparisons among sampling periods indicated that cover of planted forbs during 1982 was significantly higher than for any other sample period. In addition, there appeared to be a proportional, inverse relationship between planted and invaded forb cover.

Shrub cover on newly established quadrats during the 1982 growing season averaged 4.4 percent for planted species and 0.4 percent for invaded shrubs. Total shrub cover accounted for 9.7 percent of total cover on Plot R-1. Big sagebrush (Artemisia tridentata), winterfat (Ceratoides lanata) and rubber rabbitbrush (Chrysothamnus nauseosus) were the most common planted species, whereas broom snakeweed (Gutierrezia sarothrae) was the only invaded shrub encountered. No significant differences in cover of planted shrubs were noted for 1982; however, comparisons among years showed that cover for 1982 was significantly higher than that for all other years except 1980.

Cover for all species over all treatment combinations on Plot R-2 averaged 38.6 percent, which was slightly lower than that recorded at Plot R-1. Although the two study sites are located at approximately the same elevation, reduced effective precipitation at Plot R-2 relative to R-1 may result from its southeasterly exposure. Mean cover for 1982 was 8.5 percent higher than that for 1981, which may have been due, in part, to the use of newly established sample quadrats.

Planted grasses accounted for 36 percent of the total cover on Plot R-2. This was a slightly lower percentage than that noted in either 1981 or 1980. Invaded grasses accounted for approximately 10 percent of total grass cover. Wheatgrass species and Indian ricegrass were the most common planted grass species while squirreltail (Sitanion hystrix) and needle-and-thread (Stipa comata) were the common invaded grasses. No significant differences in cover of planted or invaded grasses were noted among treatment combinations based on 1982 data. However, comparisons among years indicated that cover of invaded grasses was significantly higher in 1976 than any other sample period. Cover of planted grass species for 1980 and 1982 was similar, with the remaining four years of data having significantly lower cover of planted grasses.

Cover of planted forbs averaged 9.8 percent on Plot R-2 during 1982, or approximately 25 percent of the total mean cover. This represented a slight increase from cover recorded during 1981 and 1980. The most

prevalent planted forb species were Lewis flax and cicer milkvetch. Douglas chaenactis, Cryptantha, Machaeranthera and lobeleaf groundsel (Senecio multilobatus) were common invaded forb species which contributed to an average cover of 1.9 percent. No significant differences in forb cover among treatment combinations were noted for 1982. Comparisons of cover among sample periods showed that cover of planted species for 1982 was significantly higher than for any of the previous years. Conversely, cover of invaded forb species was at a six year low during the 1982 season.

Shrub cover for planted species averaged 10.5 percent during 1982. Combined with an average of 0.8 percent cover for invaded species, total shrub cover accounted for 29 percent of the total mean cover for all species. This represented a substantial increase in shrub cover relative to 1981, which may have been related to the use of newly established sample quadrats during 1982. Rabbitbrush species were the most common planted shrubs encountered whereas broom snakeweed was the only invaded shrub recorded. No significant differences in cover of planted shrub species were noted for 1982 data, as based on the 16 treatment combinations tested. However, cover for the three year period 1980-1982 was significantly higher than either 1976, 1977 or 1978. Although earlier data indicated no mulch and/or hydromulch treatments had favored planted shrub species more so than straw mulch treatments, this effect was not evident in either the sixth or seventh years of growth.

Species richness on Plots R-1 and R-2 is lower than that recorded in the surrounding Sagebrush and Pinyon-Juniper vegetation types; however, as is the case in these relatively undisturbed plant communities, the majority of herbaceous cover on Plots R-1 and R-2 results from three or four grass species, and two or three forb species. Cover of woody species on the two sites is well below that recorded in undisturbed communities. With time, species richness may increase as species from the surrounding communities disperse and become established within the study areas. As this occurs and as the existing individual shrubs on the two study areas reproduce, cover of woody species can be expected to increase. But, plantings of con-

tainerized shrub and/or tree species will probably be required in order to meet cover/density requirements for woody species during future reclamation efforts. Data on the seeding mixture used for Plots R-1 and R-2 will be useful for future planning and permitting activities. However, consideration should also be given to species which have been demonstrated as being successful in other research efforts (Redente and Cook 1981).

The analyses of 1982 data show that, after seven years, few significant differences exist among the 16 mulch and fertilizer treatments tested on Plots R-1 and R-2. During the first several years of growth, however, cultural amendments were of importance. Mulch is of particular importance on steep areas both to reduce erosion and to maintain soil moisture for seedlings. Moisture retention is of particular importance on southerly exposures, as demonstrated during the first several years of growth on Plot R-2. Erosion control is, of course, important on all sites where slope angles promote rill and/or gully erosion. In terms of promoting cover of planted species and inhibiting competition from invading species during the period of establishment (the first several years after planting), data from Plots R-1 and R-2 indicate that hydromulch is preferable to either straw mulch treatment tested. From an operational standpoint, application of hydromulch from benches on disturbed sites would be preferable to operating straw mulching/crimping equipment on steep slopes.

Inconclusive results were obtained from Plots R-1 and R-2 regarding the application of fertilizer. Nevertheless, the use of fertilizer during future planning and reclamation efforts should not be ruled out. Other researchers in the Piceance Basin have noted that biomass of seeded grasses increases in response to fertilization (Redente and Cook 1981). Native shrub species also were shown to benefit from fertilization in the aforementioned study. The type, time of application and quantity of fertilizer utilized will be dependent on site specific conditions.

Data obtained from Plots R-1 and R-2 after seven years of growth indicate that an effective vegetative cover capable of self-regeneration appears to have been established on disturbed sites in the vicinity of Tract C-a.

This has been accomplished by seeding topsoiled sites with a diverse mixture of grasses, forbs and shrubs. Such sites may require fertilization and should be mulched in order to control erosion and to assure the greatest chance for successful seedling establishment. The resultant vegetative cover and/or biomass of herbaceous species has been equivalent to that in surrounding sagebrush or pinyon-juniper communities. Therefore, revegetated sites are expected to provide forage equivalent to that present prior to disturbance.

## 2. Experimental Revegetation on a Simulated Processed Shale Disposal Site

Cover for all species averaged 43.5 percent on the control (no processed shale) portion of R-3 and 43.8 percent on the treatment (underlain by processed shale) portion. The cover of herbaceous species recorded during 1982 was higher on both the control and treatment portions of the study area than that recorded during either 1979, 1980 or 1981.

Planted grasses accounted for 42.1 and 38.1 percent of the total mean cover on control and treatment portions of R-3, respectively. Invaded forb species accounted for 10.3 and 8.4 percent of the total mean cover on control and treatment portions of the study area, respectively. Wheatgrass species and Indian ricegrass continued to be the most prominent planted species while the most prominent invaded grasses included cheatgrass (*Bromus tectorum*) and crested wheatgrass (*Agropyron cristatum*). Aside from the significantly higher cover of invaded grasses on hay mulch relative to no mulch treatments, no differences were noted among the various treatment combinations if species were lumped by growth form. When considered on an individual species basis, some significant differences were evident. Furthermore, comparisons among years showed that cover of planted grasses was significantly higher in 1979 than during any other sample period.

Cover of planted forb species on Plot R-3 accounted for 15.9 percent of total mean cover on the control and 14.6 percent on the treatment side. Invaded forbs, on the other hand, accounted for only 1.8 and 1.6 percent of the total mean cover for control and treatment portions. Cicer milkvetch

contributed the largest proportion of planted forb cover while Machaeranthera, Cryptantha, and twinpod (Physaria floribunda) were the more common invaded forbs. No significant differences in cover of planted forbs were evident among treatment combinations during 1982. However, forb cover for 1982 was lower, though not significantly different from that recorded during 1981.

Shrub cover averaged 11.6 on the control and 15.6 percent on the treatment portion of R-3, accounting for 26.7 and 35.6 percent of the total mean cover respectively. Winterfat and fourwing saltbush (Atriplex canescens) were the most prominent planted species, and broom snakeweed was the primary invaded shrub species encountered. Species lumped by the shrub growth form showed no significant differences in cover among treatment combinations. Data partitioned by individual species showed that rabbitbrush was apparently favored by hydromulch, low seeding rates and/or the processed shale substrate. Comparisons among years showed that shrub cover for 1979 and 1982 was significantly higher than for the four remaining sample periods.

Biomass for herbaceous species during 1982 averaged 84.9 and 79.1 $gm/m^2$ on control and treatment portions of Plot R-3, respectively. Planted grasses accounted for 77 and 80.7 percent of the mean standing crop of herbaceous species on control and treatment portions of the site, respectively. Grasses as a whole showed no significant differences in aboveground biomass as based on substrate, seeding or mulch treatments. However, some differences among treatments were noted when individual species were considered.

The standing crop for planted forb species averaged 10.9 $gm/m^2$ on the control portion and 9.2 $gm/m^2$ on the treatment side, or approximately 12 percent of the standing crop of all herbaceous species. No significant differences in forb biomass were noted among the various treatment combinations based on the 1982 data. However, the mean biomass for 1982 (10.0 $gm/m^2$) was significantly higher than the 3.5 $gm/m^2$ recorded during 1979.

Precipitation at Plot R-3 totalled 10.64 inches for the April-October 1982 period. The highest monthly total occurred during September when an average of 3.73 inches was recorded. The seven month precipitation total for 1982 was the highest recorded since R-3 was established in 1976.

Results of soil analyses for 1982 indicated that there were no significant differences in soil conductivity between control and treatment portions of Plot R-3. Analyses were also made on tissues of five plant species (three replicates per species for each substrate) to determine the content of arsenic, boron, fluoride, molybdenum and selenium. The only significant difference noted between the shale and no shale substrates was for boron in rubber rabbitbrush. In this instance, the content of boron was significantly higher on the control (no shale) portion. When determinations for trace elements within plant materials were compared with values from R-3 soil samples, it appeared that all of the trace elements tested were being accumulated to some extent by the five plant species, regardless of substrate type.

After six years of growth on a reconstructed soil profile overlying processed shale, an effective vegetation community capable of self-regeneration appears to have been established on Plot R-3. As noted with similar study areas on surface disturbed sites, the majority of herbaceous cover results from three or four grass species, and two or three forb species. From this respect, the vegetative cover is similar to that of the surrounding undisturbed communities; however, species richness on the revegetated site is lower than natural communities, as is the case for cover of woody species. Use of containerized shrubs and trees will help achieve greater cover and density of woody species during future reclamation efforts.

At present, few significant differences in cover and biomass exist between the seeding rate, mulch and substrate treatments tested. Results thus far indicate that seeding rates for mixtures of grasses, forbs and shrubs should be 22 to 28 kg/ha. The use of hydromulch (1.7 MT/ha) is beneficial from both biological and operational standpoints; however, the favorable

effects are important during the first several years of growth and are generally not evident in subsequent data. The results of mulch treatments on Plot R-3 inidicate that, if a "natural" mulch is required, the use of native hay mulch is preferable to straw (as tested on Plots R-1 and R-2) because fewer undesirable species are introduced with the native hay mulch.

Continued study of Plot R-3 can be expected to better delineate changes in species richness, cover and biomass as succession continues on the study area. Furthermore, studies of soil moisture and root penetration into (or perhaps through) the reconstructed soil profile will provide useful information on the long term adequacy of this type of barrier for segregating processed shale from surface growth media. Because the active rooting zone on Plot R-3 is well into the rubblized overburden, it is important that the materials derived from this overburden barrier are amenable to plant growth. This appears to be the case for Uinta Sandstone underlying Plot R-3.

B. Mule Deer Habitat Modification Study

Cover and density of shrub species, as well as cover of herbaceous species, was assessed along transects established within two study areas, one in which rotochopped areas were aligned parallel and the other perpendicular to the prevailing winds. No significant differences were noted among chopping, seeding or fertilization treatments on the study area aligned perpendicular to the wind. However, cover of shrubs and/or herbaceous species appeared to be related to both fertilization and rotochopping on the parallel orientation. Cover was significantly higher on fertilized portions as well as those which were not rotochopped. In spite of the aforementioned differences, very few of the planted species appeared to be doing well. Therefore, the differences between treatments resulted from sprouting of sagebrush or invasion of other non-planted shrubs and/or forbs. Deer use of the modified sagebrush habitat was minimal during 1982; consequently, too few pellet groups were found along any of the transects to determine differential deer use among treatment combinations.

C. Shrub Growth Enhancement on a Simulated Mine Site and/or Disposal Pile Bench

A simulated mine site/disposal pile bench was constructed on Tract C-a in early 1982. The simulated bench is designed principally to evaluate the effects of water harvesting techniques on shrub growth. In addition, the effects of topsoil depth and deer browsing are to be evaluated. The bench is designed to concentrate available moisture in certain areas using water bars and variations in slope. Various combinations of fencing and topsoil applications will also be tested. Shrubs were planted in each of the resulting treatment areas in the spring of 1982. Shrub growth will be evaluated on a yearly basis beginning in 1983 to identify any effects of the various treatments on shrub growth. The success of the water harvesting techniques will be evaluated by periodic measurements of soil moisture content at fixed locations. The results of these evaluations will be included in subsequent MDP Environmental Monitoring Reports.

D. Study to Alter Natural Succession After Fire for Enhanced Deer-Livestock Forage

After the natural occurrence of a fire in Yellow Creek bottom in September 1981, a program was established to study methods which might improve the forage for deer and livestock in a burned area. The study includes two seeding rates of a seed mixture containing 12 species of valuable forage plants and various grazing/browsing exclosures. The effects of fire, livestock grazing pressure, deer browsing pressure, and seeding rates on plant species percent cover will be estimated in 1983.

E. Run-of-Mine Lysimeter

A lysimeter was set up in the field to collect leachate from a raw shale pile at 5, 10, and 15 feet. Data have now been collected and analyzed for two years. The conductivity of leachate in the 5-foot collector has been fairly stable at approximately 20 millimhos per cm, whereas the conductivity of leachate in the 15-foot collector increased slightly from

30 millimhos per cm in 1981 to 35 millimhos per cm in 1982. There was less precipitation and leachate in 1982 than in 1981. The primary differences between leachate from the 5-foot and 15-foot collector are the much higher concentrations of magnesium and sulfate ions from the deeper collector. Magnesium sulfate dominates the inorganic ion composition in samples from both leachate collectors.

F. Special Meteorological Investigations

Two field projects were undertaken: a tracer study of fugitive emissions, and an upper air meteorological study. The tracer study was conducted during the summer of 1981, and the upper air study was conducted during the summer of 1982.

The tracer study was designed to simulate emissions near the surface (e.g., fugitive dust from hauling, crushing, dumping and storage facilities) from an oil shale production facility, under worst case meteorological conditions. Sulfur hexafluoride was used as the tracer, and was released at 1.7 meters at a potential plant site during early morning hours, under conditions of light drainage winds and stable atmospheric conditions. Measuring the resulting tracer gas concentrations in the ambient air downwind of the release point revealed that there was very little mixing before sunrise in the air draining down the shallow gulches. After sunrise, mixing within the lowest surface boundary layer rapidly increased until the tracer gas was diluted below detection limits. The experimental results showed that mixing near the surface is very limited until sunrise, and is probably the worst case for low level emissions. This data set can be used in the future to validate air quality models applied to this situation.

The upper air meteorological study was conducted as a cooperative effort between Rio Blanco and NOAA's Atmospheric Turbulence and Diffusion Laboratory. An instrument package consisting of a tethersonde and airsonde was used to collect meteorological data from the surface to several kilometers above the ground at three locations near Tract C-a. All of the

data has not yet been reduced and analyzed, so only preliminary results are available at this time.

The most unusual condition noted to date in this study occurred at night under light winds and clear skies. A mid-level easterly wind extending from 50 meters to 1000 meters above the ground surface was found, sandwiched between a surface westerly drainage wind and the upper level westerlies of the general atmospheric circulation. Although unexpected, this phenomenon has been measured before near Tract C-a. Additional investigation is needed to better characterize this easterly wind, particularly since it may alter the location and the extent of the air quality impacts from an oil shale facility.

G. Comparison Study of Inhalable and Total Suspended Particulates

Two $PM_{10}$ monitors (which have a 50 percent particle cutpoint of 10 μm) were installed colocated with standard Hi-Vols (measuring Total Suspended Particulates (TSP - particles up to 30-50 μm) in late August, 1982, to measure the ratio of $PM_{10}$ to TSP near Tract C-a. This comparison is particularly appropriate with the current deliberations over a size specific particulate standard. The data collected to date show a $PM_{10}$/TSP ratio averaging 0.6, but this is based upon a small data set collected after the peak concentrations of particulate matter had occurred in early and mid-summer. A more representative data set will be available at the end of the 1983 monitoring period.

H. Yellow Creek Stream Classification Survey

The Colorado Department of Health, Water Quality Control Commission proposed a set of stream use classifications and water quality numeric standards for segments 12 and 13 of the White River drainage system. A two season survey was conducted in April (spring runoff) and August (dry season) to evaluate the aquatic habitat for segment 13, Yellow Creek and tributaries. Data collected in this survey provided information that was used to present RBOSC's position in the public hearings held in October 1982 for the lower Colorado, Yampa, Green and White River systems.

Intermittent flow was found to be the limiting factor for most of the Yellow Creek drainage system. Permanent flow conditions were found only in the lower portions of Yellow Creek and near the head waters of the drainage system east of Cathedral Bluffs. The majority of the middle portion of Yellow Creek, lower Big Duck Creek, Little Duck Creek, and Dry Fork Gulch, were found to exhibit dry stream conditions in both survey seasons. Flow was variable in both seasons in the lower Yellow Creek segments and in Corral Gulch, where permanent flow conditions exist.

Stream conductivity and habitat characterization data were also collected. These data indicated that the lower Yellow Creek segments exhibited higher stream conductivity and contained a wider variety of aquatic habitat conditions than the spring feed head water segments on the tributaries feeding into Yellow Creek.

As a result of these data and other testimony, Segment 13 was classified for agriculture use only. No water quality standards were placed on the Yellow Creek drainage system.

I. Toxicology

In 1981, a toxicology program to develop data on MIS and Lurgi process materials was initiated. Test results to date indicate that none of the shale oil, process water, raw or spent shale produce significant toxicity when administered as single doses either orally or by skin contact. Oils were minimally irritating to the eye. Spent shale (Lurgi) was also mildly irritating, probably due to mechanical irritation. Shale oils and process water are mildly irritating to the skin, however the oils also stain the skin precluding the use of conventional criteria for evaluating dermal irritation. Light Lurgi oil vapor is esssentially non-toxic in acute inhalation exposure.

Shale oil samples showed mutagenic response in several of the cell assay tests. No such response was observed for process waters, raw or spent shale. Cytogenetic studies showed some response but produced no indication of increased tendency toward aberrant chromosomes.

Preliminary dose-ranging studies with pregnant and non-pregnant test animals showed reduced body weight but no indication of interference with pregnancy or with survival of off-spring.

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# RIO BLANCO OIL SHALE COMPANY
# MODULAR DEVELOPMENT PHASE
# MONITORING REPORT 11

January 1982 - December 1982
YEAR-END REPORT

APPENDICES

Prepared by:
RIO BLANCO OIL SHALE COMPANY
AURORA, COLORADO

April 30, 1983

# APPENDIX 2-O

## Atmospheric Studies

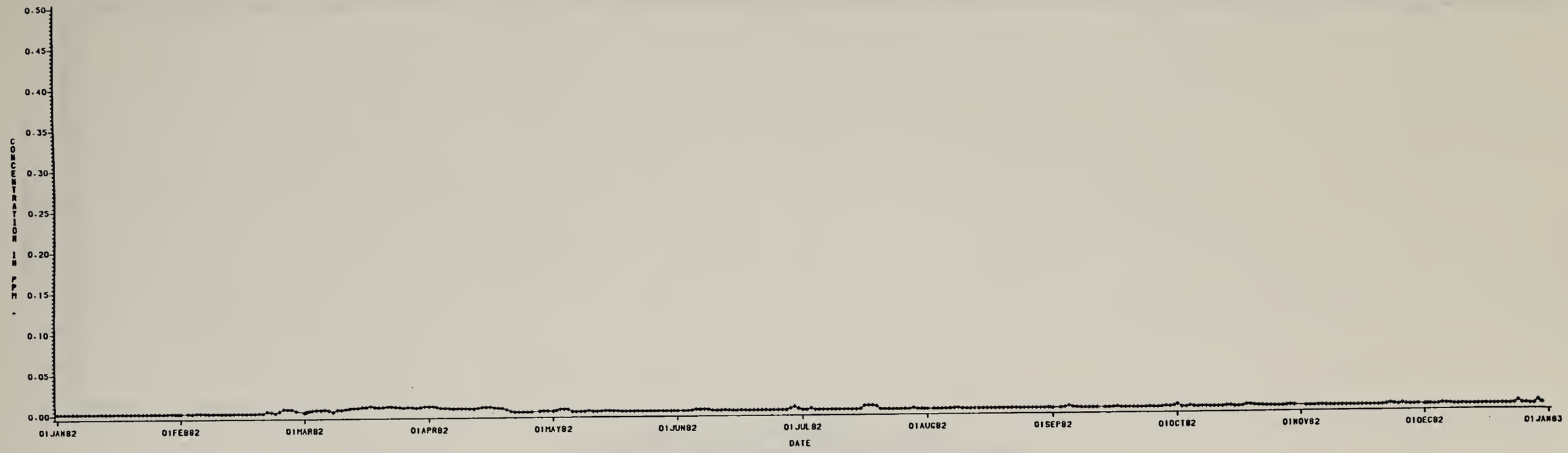
# APPENDIX 2-1

## Air Quality Data

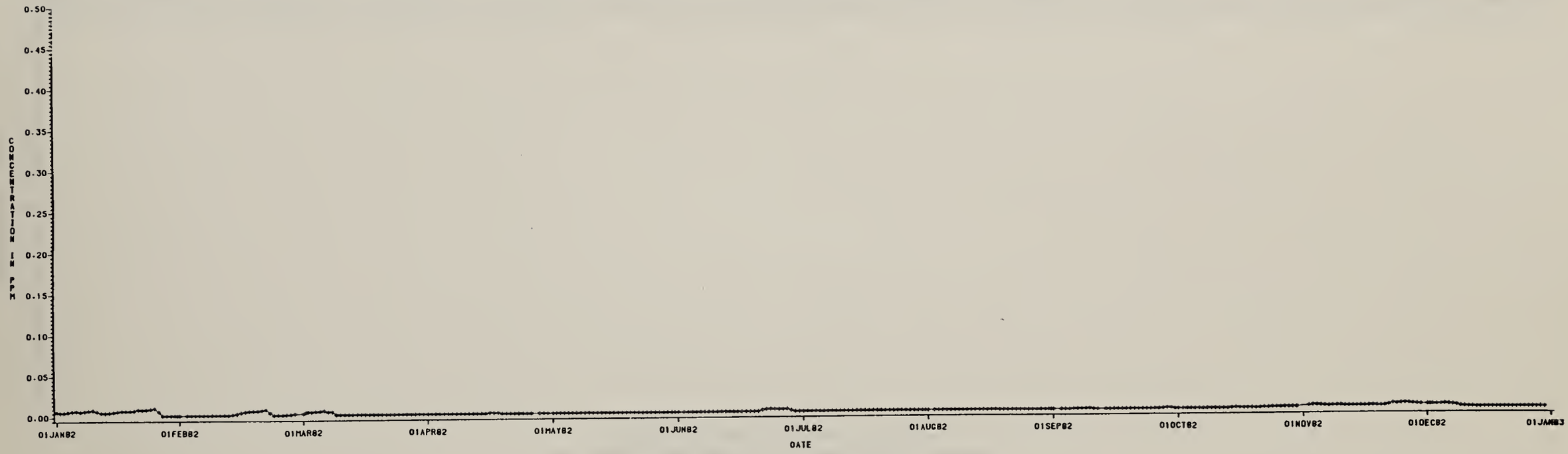
APPENDIX 2-1.1

Plots of Gaseous Constituents Data at Site 1

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
SULFUR DIOXIDE DATA (PPM) – SITE 1

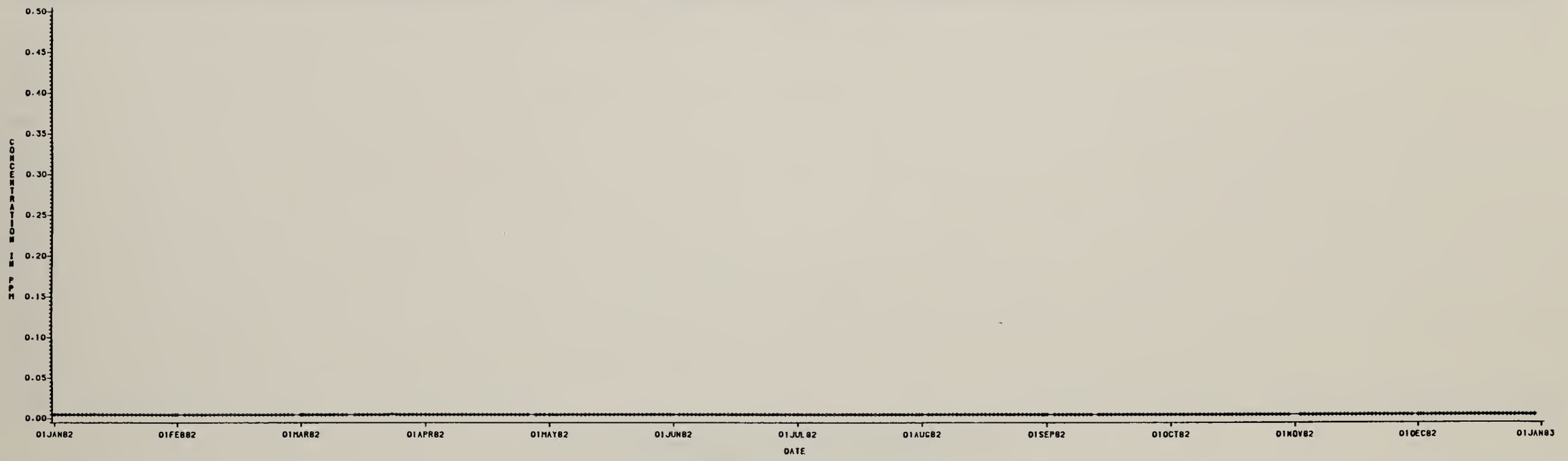


RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
HYDROGEN SULFIDE DATA (PPM) – SITE 1

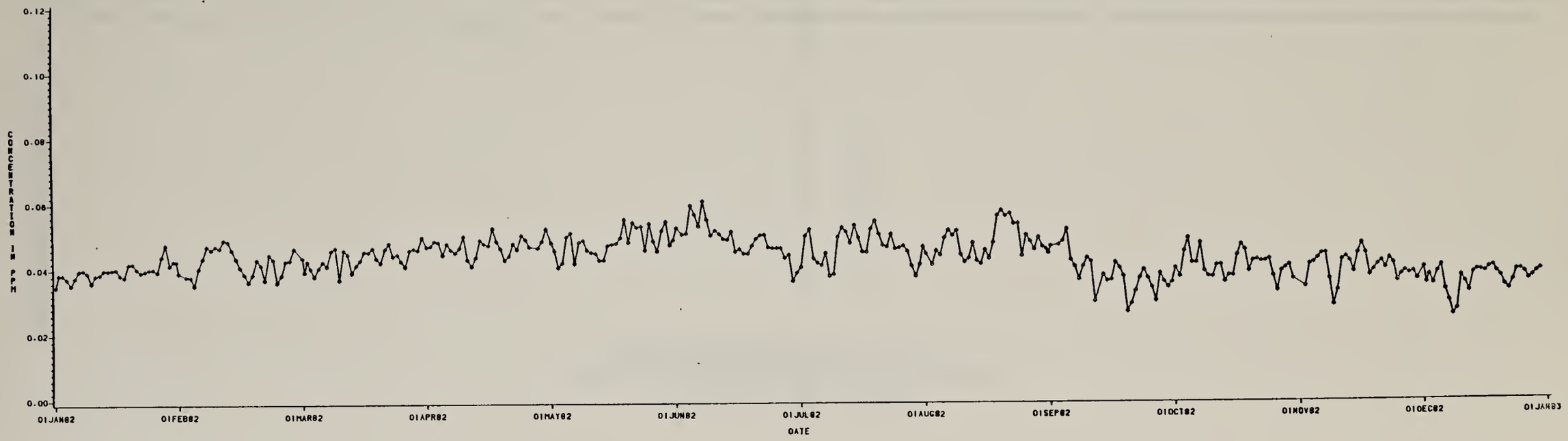


RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
NITRIC OXIDE DATA (PPM) – SITE 1

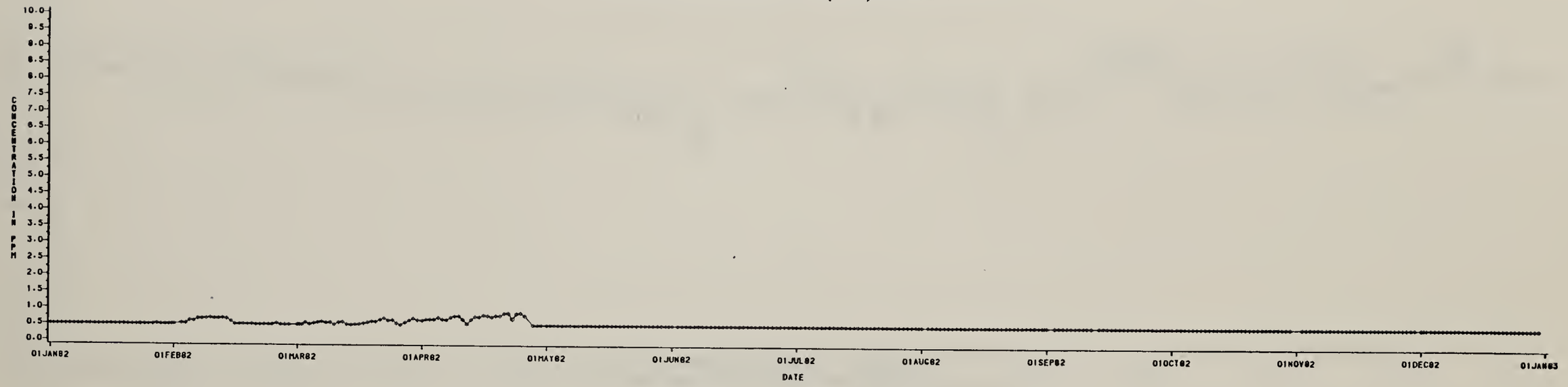
RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
NITROGEN OXIDES DATA (PPM) – SITE 1



RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
OZONE DATA (PPM) – SITE 1



RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
CARBON MONOXIDE DATA (PPM) – SITE 1



APPENDIX 2-1.2

Total Suspended Particulate Data - Sites 1, 2, and 3

TABLE 1
1982 RBOSC TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

| DATE | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|
| 03JAN82 | 5 | 4 | 5 |
| 06JAN82 | 7 | 2 | 9 |
| 09JAN82 | 2 | 3 | 3 |
| 12JAN82 | 5 | 6 | 4 |
| 15JAN82 | 5 | 6 | 6 |
| 18JAN82 | 8 | 10 | 10 |
| 21JAN82 | 17 | 15 | 18 |
| 24JAN82 | • | 4 | 3 |
| 27JAN82 | 8 | 6 | 13 |
| 30JAN82 | • | 7 | 9 |
| 02FEB82 | 5 | 7 | 5 |
| 05FEB82 | 10 | 10 | 6 |
| 08FEB82 | 8 | 10 | 7 |
| 11FEB82 | 7 | 6 | 6 |
| 14FEB82 | 5 | 4 | 4 |
| 17FEB82 | 3 | 2 | 2 |
| 20FEB82 | 4 | 5 | 3 |
| 23FEB82 | 9 | 9 | 12 |
| 26FEB82 | 9 | 9 | 9 |
| 01MAR82 | 12 | 13 | 15 |
| 04MAR82 | 1 | 1 | 1 |
| 07MAR82 | 6 | • | 6 |
| 10MAR82 | 5 | 5 | 14 |
| 13MAR82 | 8 | 7 | 9 |
| 16MAR82 | 2 | 1 | 7 |
| 19MAR82 | 12 | 10 | 12 |
| 22MAR82 | 9 | 11 | 16 |
| 25MAR82 | 10 | 11 | 33 |
| 28MAR82 | 8 | 8 | 10 |
| 31MAR82 | 8 | 8 | 16 |
| 03APR82 | 14 | 8 | 20 |
| 06APR82 | 26 | 32 | 40 |
| 09APR82 | 8 | 12 | 12 |
| 12APR82 | 27 | 29 | 31 |
| 15APR82 | 28 | 26 | 37 |
| 18APR82 | 45 | 44 | 50 |
| 21APR82 | 16 | 14 | 18 |
| 24APR82 | 27 | 23 | 23 |
| 27APR82 | 17 | 14 | 13 |
| 30APR82 | 28 | 24 | 34 |
| 03MAY82 | 10 | • | • |
| 06MAY82 | 20 | 17 | 18 |
| 09MAY82 | 48 | 48 | 52 |
| 12MAY82 | 8 | 10 | 8 |
| 15MAY82 | 12 | 11 | 13 |
| 18MAY82 | 31 | 25 | 40 |
| 21MAY82 | 12 | 13 | 18 |
| 24MAY82 | 16 | 16 | 18 |
| 27MAY82 | 26 | 23 | 40 |
| 30MAY82 | 12 | • | 11 |

TABLE 1
1982 RBOSC TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

| DATE | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|
| 02JUN82 | 14 | • | 26 |
| 05JUN82 | 80 | 65 | 79 |
| 08JUN82 | 33 | 29 | 50 |
| 11JUN82 | 23 | 27 | 67 |
| 14JUN82 | 29 | 28 | 53 |
| 17JUN82 | 28 | 22 | 23 |
| 20JUN82 | 19 | 18 | 30 |
| 23JUN82 | 29 | 25 | • |
| 26JUN82 | 14 | 13 | 17 |
| 29JUN82 | 32 | 26 | • |
| 02JUL82 | 31 | 24 | 32 |
| 05JUL82 | 29 | 25 | 34 |
| 08JUL82 | 16 | 18 | 25 |
| 11JUL82 | 21 | 19 | 27 |
| 14JUL82 | • | 31 | 37 |
| 17JUL82 | • | 31 | 38 |
| 20JUL82 | 55 | 30 | 71 |
| 23JUL82 | 29 | 24 | 45 |
| 26JUL82 | 19 | 16 | 18 |
| 29JUL82 | 9 | 9 | 11 |
| 01AUG82 | 19 | 19 | 25 |
| 04AUG82 | 16 | 16 | 21 |
| 07AUG82 | 23 | 21 | 27 |
| 10AUG82 | 25 | 20 | 19 |
| 13AUG82 | 9 | 8 | 13 |
| 16AUG82 | 13 | 11 | 14 |
| 19AUG82 | 20 | 17 | 24 |
| 22AUG82 | 17 | 14 | 14 |
| 25AUG82 | 15 | 14 | 21 |
| 28AUG82 | 27 | 25 | 27 |
| 31AUG82 | 13 | 14 | 24 |
| 03SEP82 | 20 | 24 | 32 |
| 06SEP82 | 14 | 16 | 15 |
| 09SEP82 | 14 | 13 | 23 |
| 12SEP82 | 14 | 11 | 11 |
| 15SEP82 | 17 | 12 | 10 |
| 18SEP82 | 14 | 10 | 10 |
| 21SEP82 | 14 | 11 | 11 |
| 24SEP82 | 15 | 14 | 18 |
| 27SEP82 | 4 | 4 | 5 |
| 30SEP82 | 17 | 17 | • |
| 030CT82 | 10 | 11 | 11 |
| 060CT82 | 5 | 6 | 3 |
| 090CT82 | 6 | 7 | 5 |
| 120CT82 | 4 | 5 | 6 |
| 150CT82 | 12 | 12 | 9 |
| 180CT82 | 19 | 22 | 22 |
| 210CT82 | 12 | 14 | 12 |
| 240CT82 | 13 | 13 | • |
| 270CT82 | 3 | 3 | 2 |

TABLE 1
1982 RBOSC TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

| DATE | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|
| 30OCT82 | 7 | 8 | 7 |
| 02NOV82 | 7 | • | 5 |
| 05NOV82 | 11 | 12 | 21 |
| 08NOV82 | 15 | 16 | 17 |
| 11NOV82 | 7 | 6 | 6 |
| 14NOV82 | 5 | 5 | 4 |
| 17NOV82 | 10 | 10 | 8 |
| 20NOV82 | 2 | 0 | 3 |
| 23NOV82 | 6 | 6 | 4 |
| 26NOV82 | 10 | 10 | 7 |
| 29NOV82 | 5 | 5 | 5 |
| 02DEC82 | 5 | 3 | 2 |
| 05DEC82 | 2 | 1 | 1 |
| 08DEC82 | 11 | 10 | • |
| 11DEC82 | 11 | 9 | • |
| 14DEC82 | 6 | • | • |
| 17DEC82 | • | 8 | 9 |
| 20DEC82 | • | 5 | • |
| 23DEC82 | 1 | 3 | 3 |
| 26DEC82 | 6 | 4 | 3 |
| 29DEC82 | 7 | 4 | 3 |

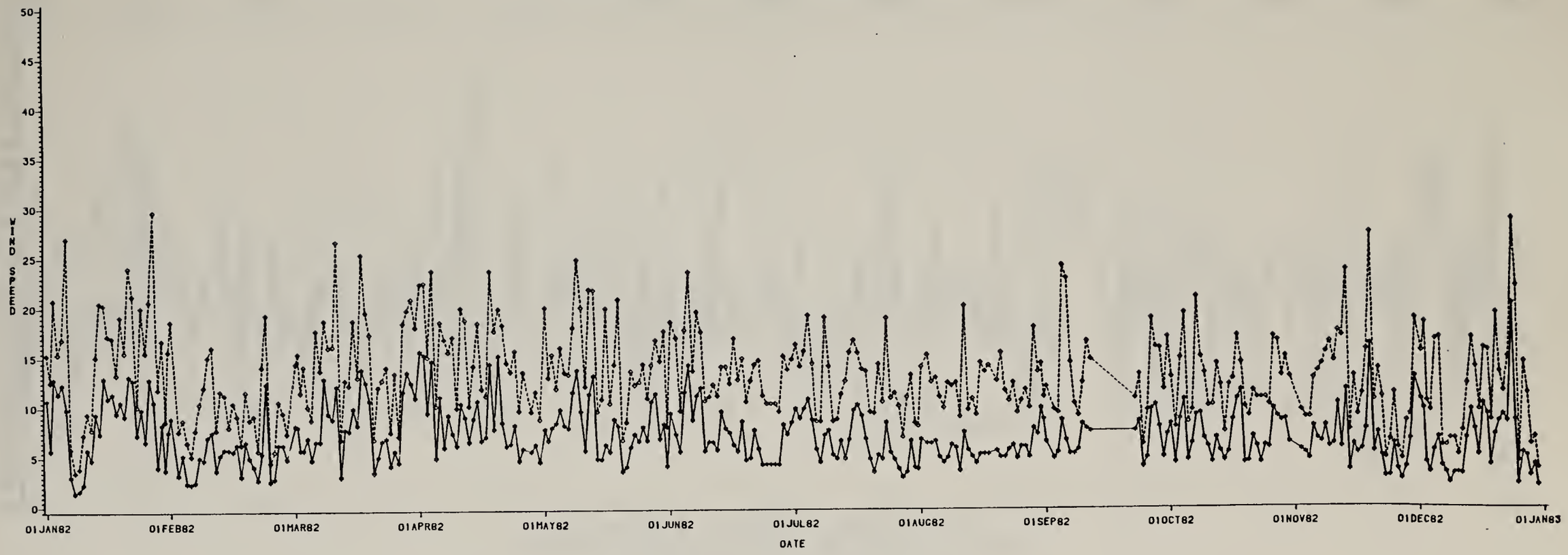
# APPENDIX 2-2

## Meteorological Data

APPENDIX 2-2.1

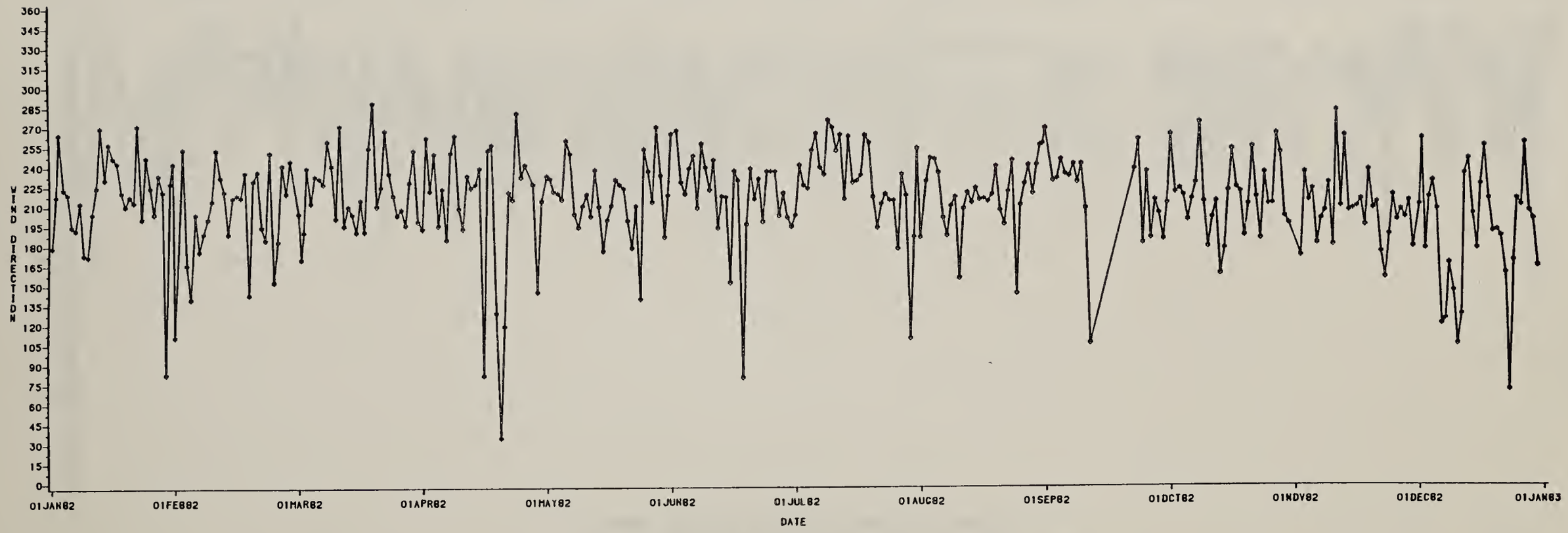
Plots of Meteorological Data at Site 1

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND SPEED (10 METER TOWER) – SITE 1

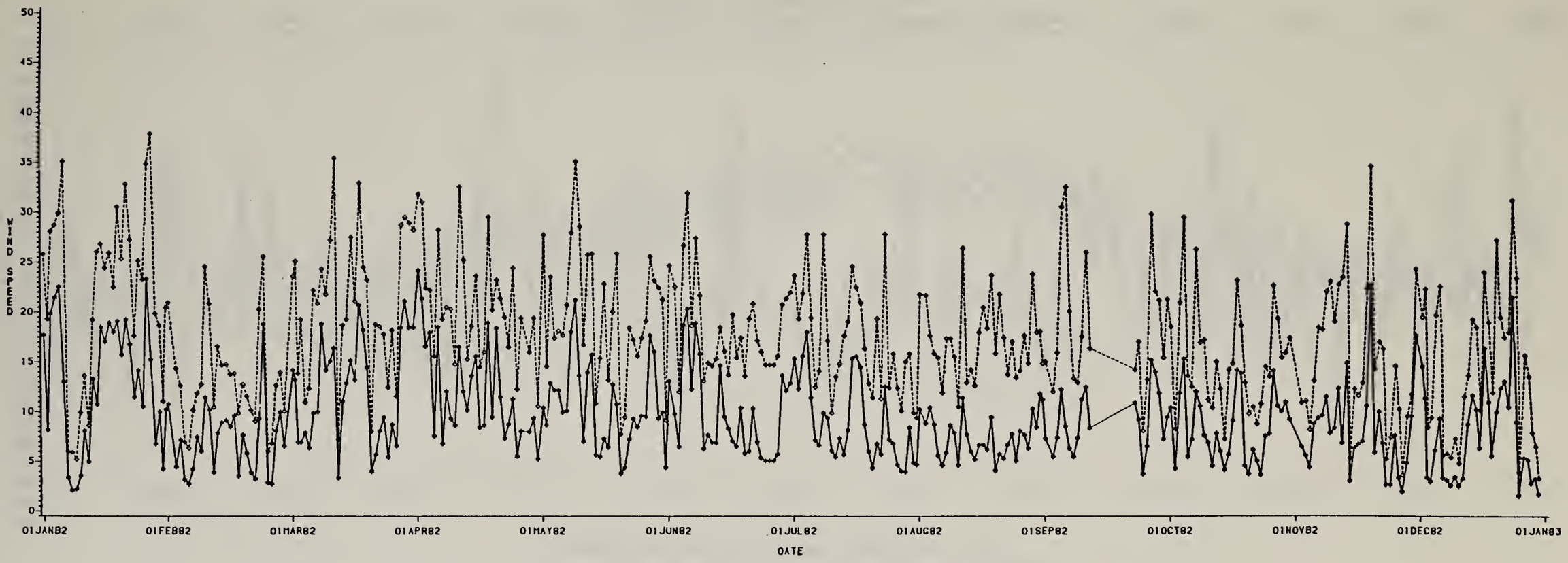



Note: Dashed, upper line, is maximum hourly Wind Speed
Solid, lower line, is the 24-hour Wind Speed Mean

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND DIRECTION (10 METER TOWER) – SITE 1

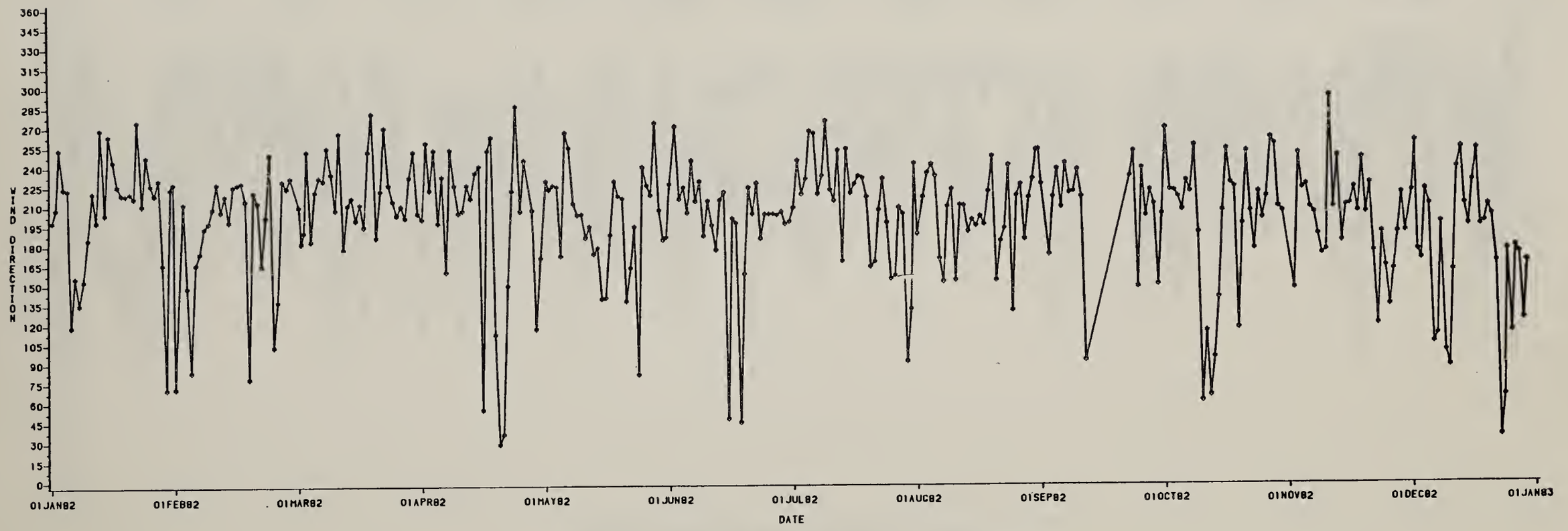


RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND SPEED (60 METER TOWER) – SITE 1

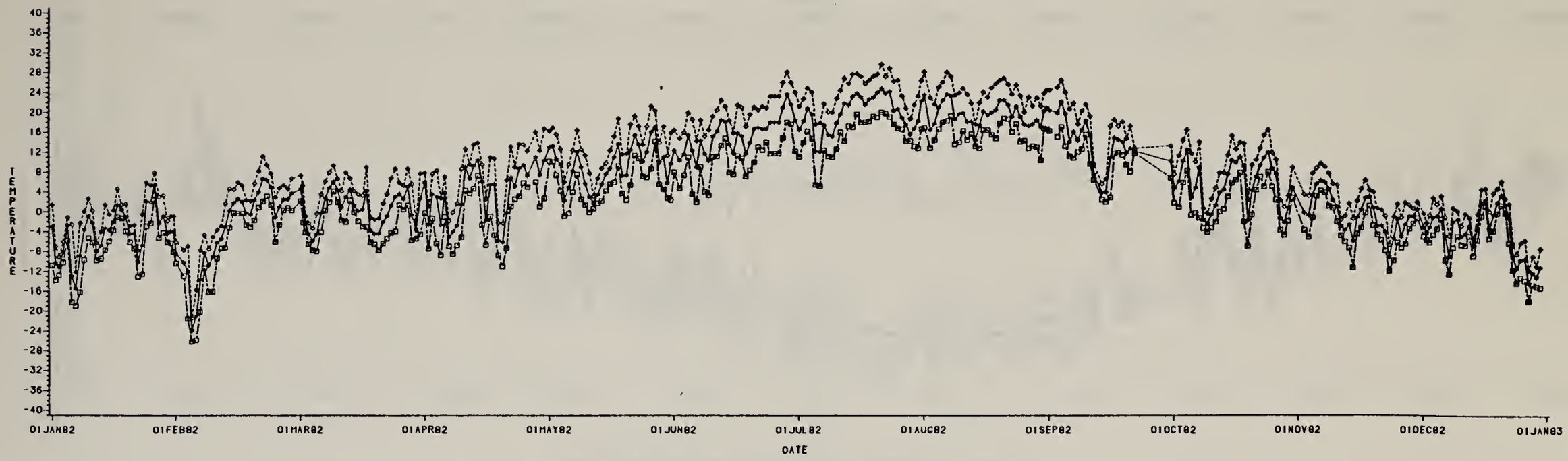



Note: Dashed, upper line, is maximum hourly Wind Speed
Solid, lower line, is the 24-hour Wind Speed Mean

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND DIRECTION (60 METER TOWER) – SITE 1

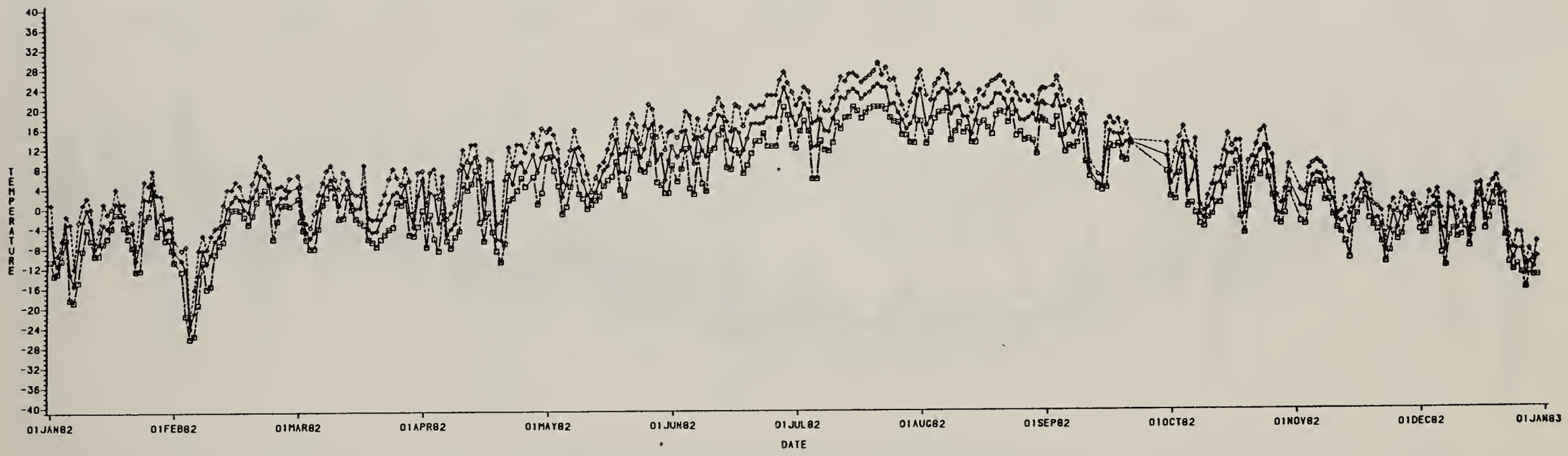


RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
AIR TEMPERATURE (10 METER TOWER) – SITE 1



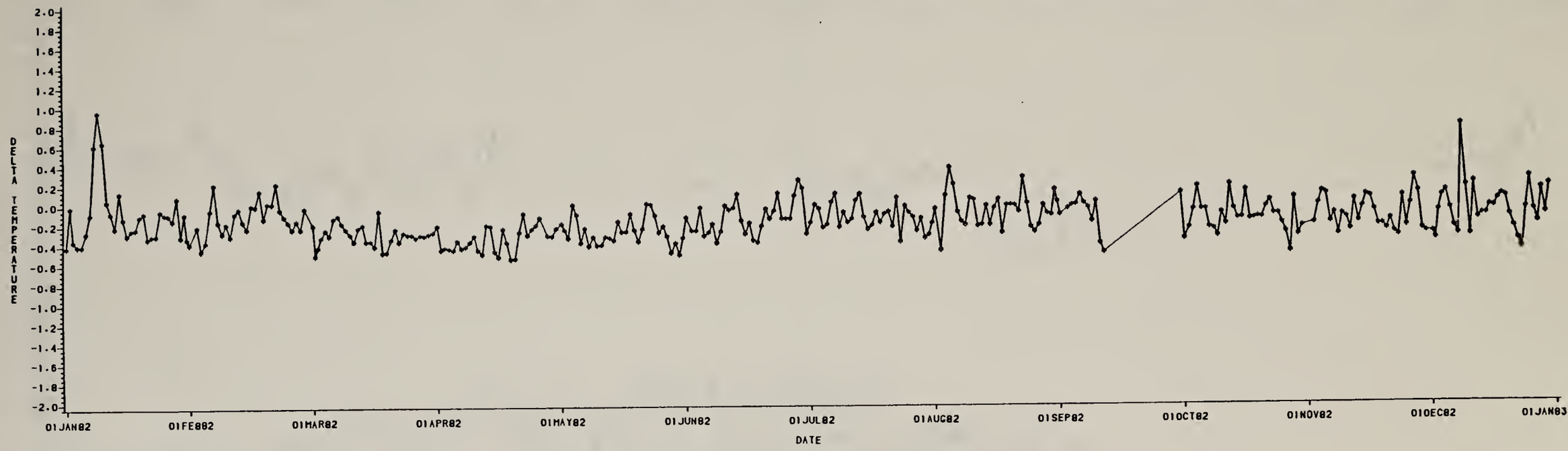

Note: Dashed, upper line, is maximum hourly Temperature
Solid, middle line, is the mean 24-hour Temperature
Dot-dashed, lower line, is minimum 24-hour Temperature

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
AIR TEMPERATURE (60 METER TOWER) – SITE 1

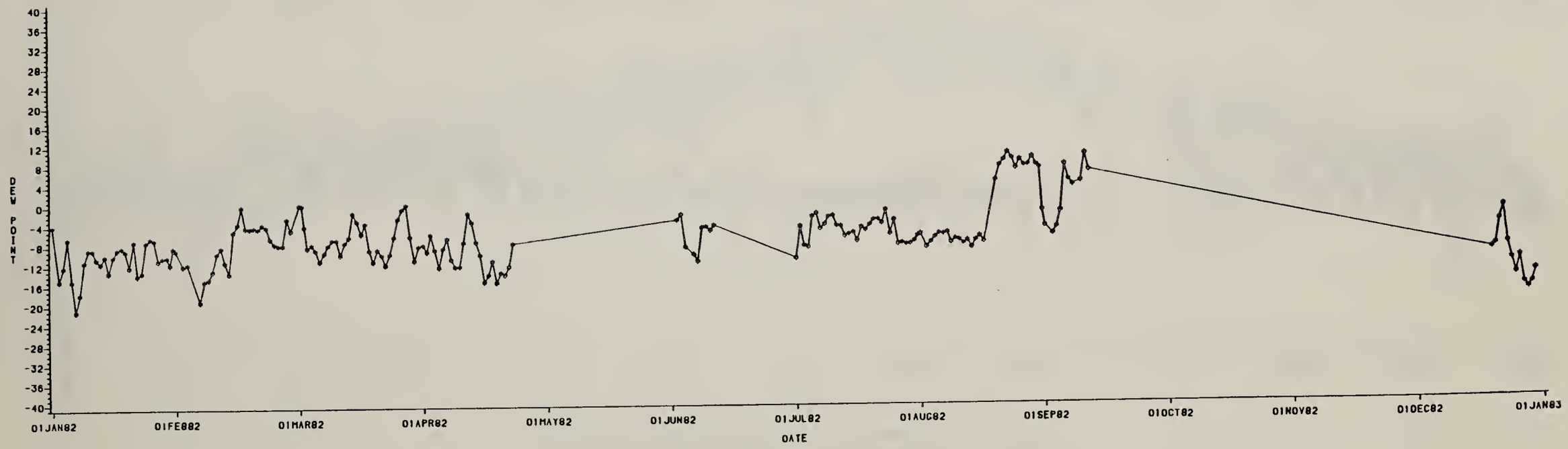



Note: Dashed, upper line, is maximum hourly Temperature
Solid, middle line, is the mean 24-hour Temperature
Dot-dashed, lower line, is minimum hourly Temperature

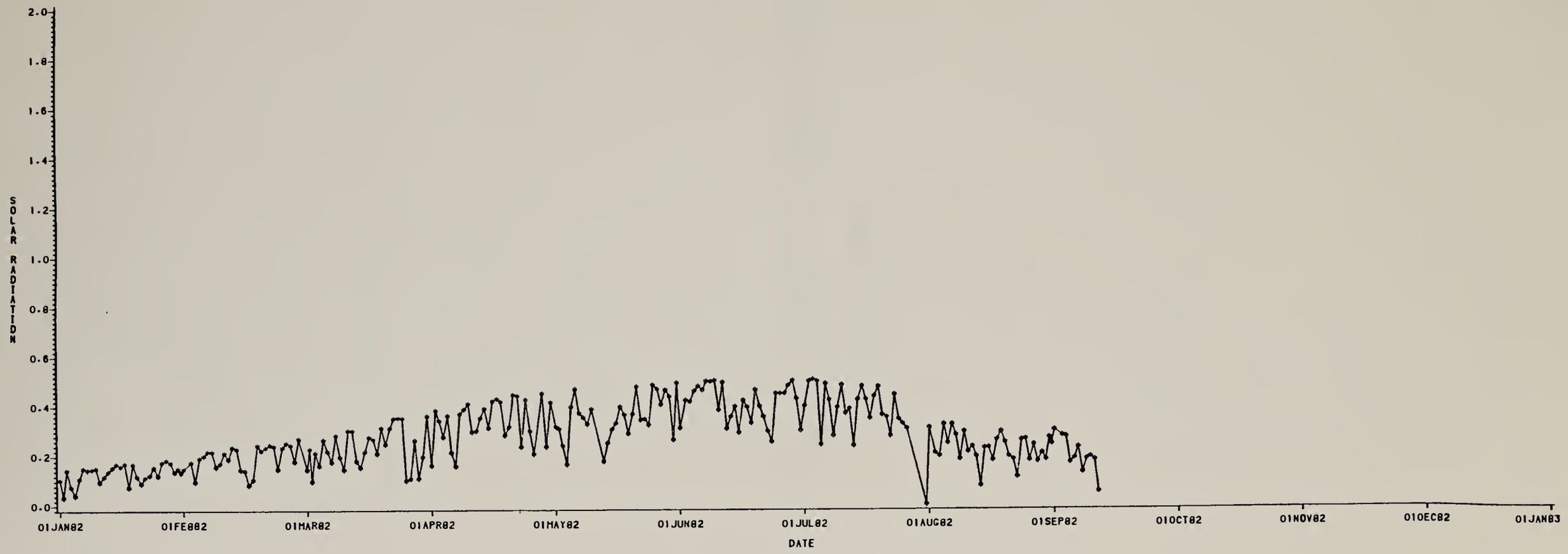
RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
DELTA TEMPERATURE (10 AND 60 METERS) – SITE 1



RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
DEW POINT (10 METER TOWER) – SITE 1



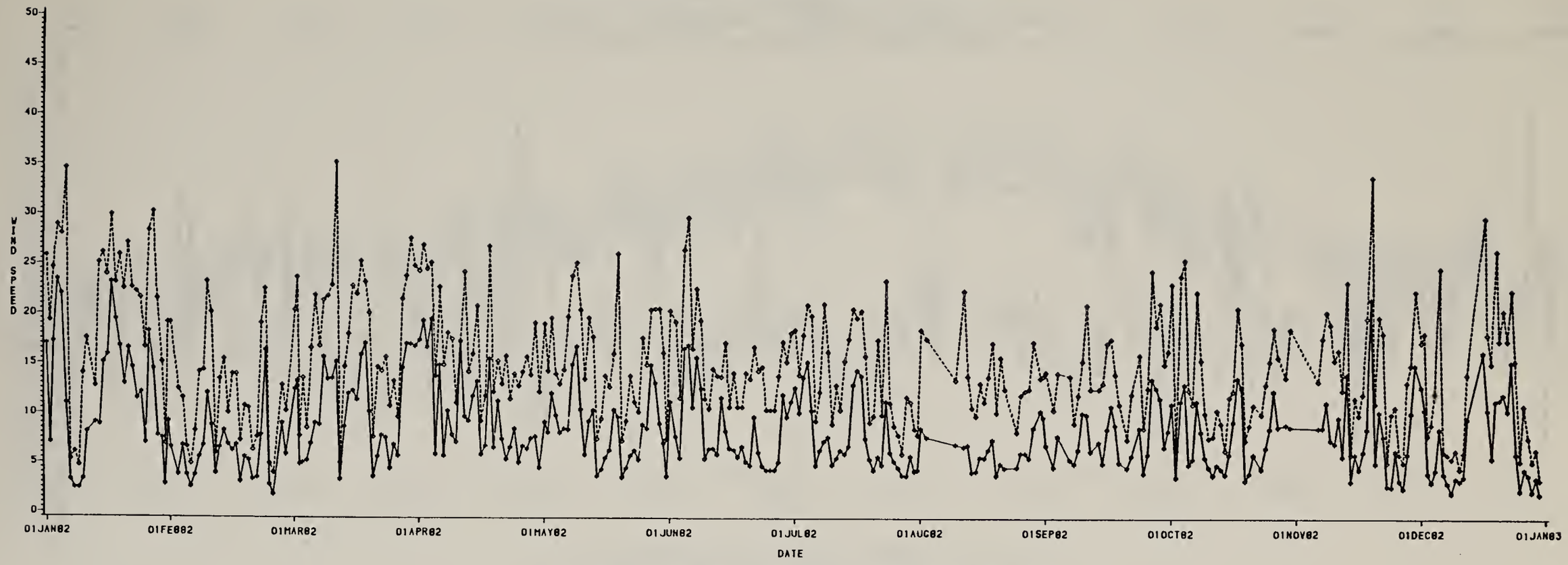
RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
SOLAR RADIATION MEASURED AT SITE 1



APPENDIX 2-2.2

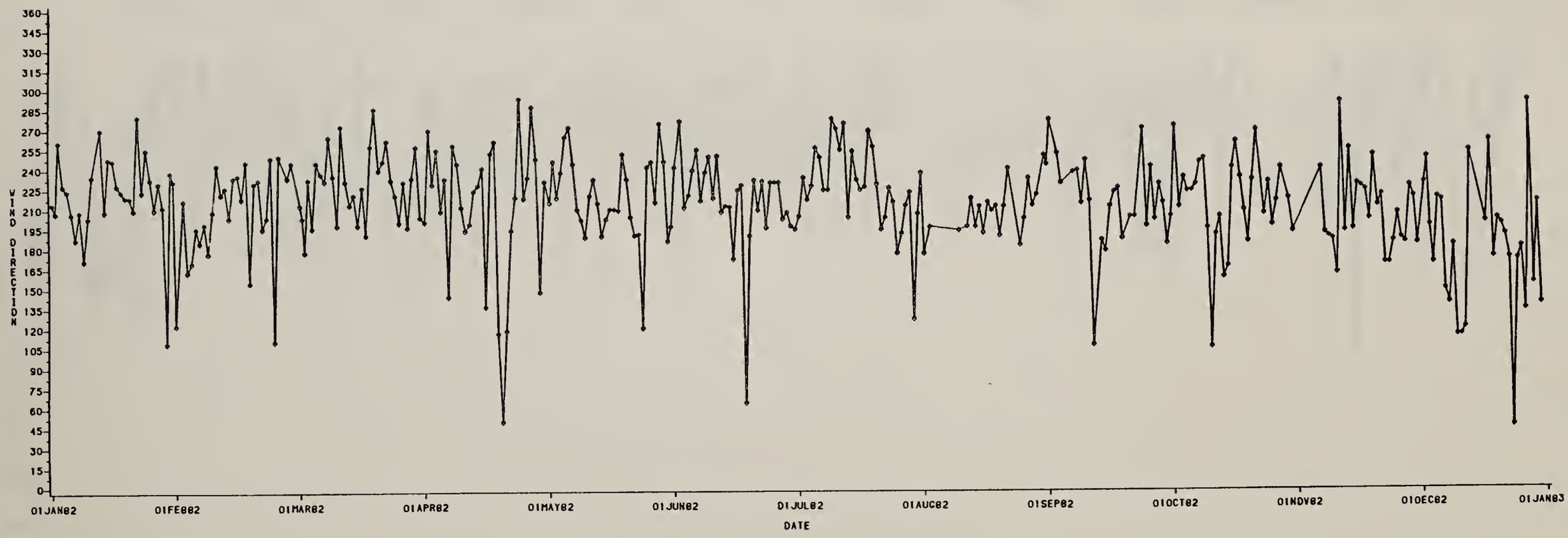
Plots of Meteorological Data at Site 2

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND SPEED (10 METER TOWER) – SITE 2

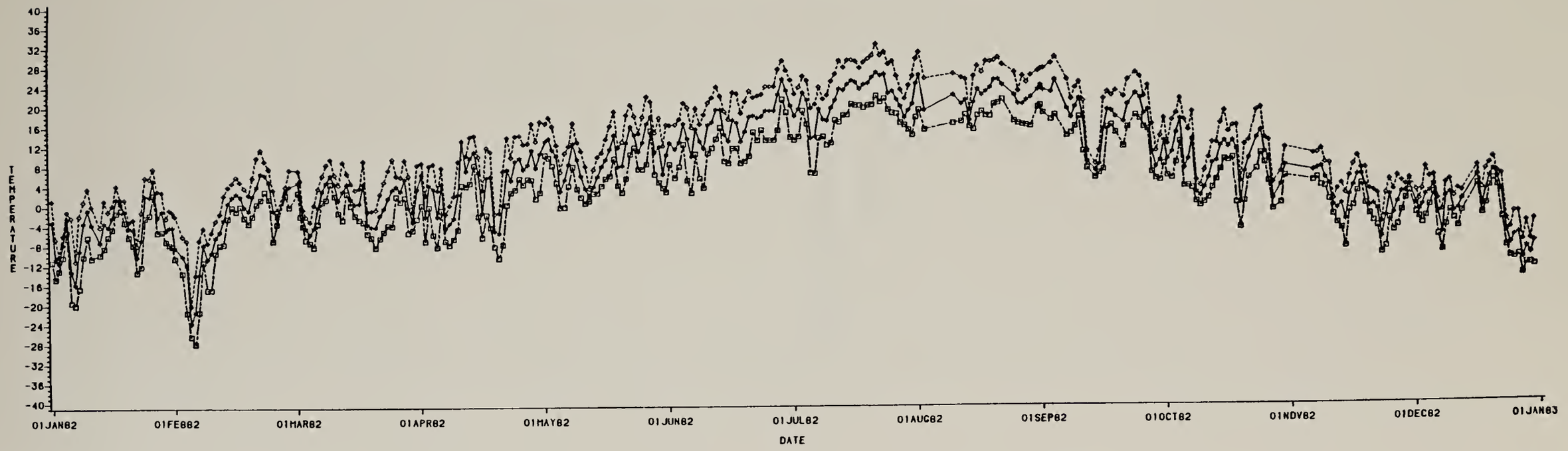



Note: Dashed, upper line, is maximum hourly wind speed
Solid, lower line, is the mean 24-hour wind speed

RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
WIND DIRECTION (10 METER TOWER) – SITE 2



RIO BLANCO OIL SHALE COMPANY
AIR QUALITY AND METEOROLOGY MONITORING PROGRAM
AIR TEMPERATURE (10 METER TOWER) – SITE 2




Note: Dashed, upper line, is maximum hourly Temperature
Solid, middle line, is the mean 24-hour Temperature
Dot-dashed, lower line, is minimum hourly Temperature

# APPENDIX 2-2.3

## Precipitation Data

APPENDIX 2-2.3

RBOSC Site 1 Precipitation Data (Inches)
July - December 1982

| Date | Weather Measure Tipping Bucket Gauge | Belfort Weighing Bucket Gauge | Wedge Gauge |
|---|---|---|---|
| 7/5 | 0.12 | 0.14 | 0.17 |
| 7/8 | 0.03 | 0.05 | 0.05 |
| 7/11 | 0.00 | 0.01 | 0.01 |
| 7/13 | 0.03 | 0.03 | 0.03 |
| 7/17 | 0.04 | 0.04 | 0.04 |
| 7/21 | 0.00 | 0.01 | 0.00 |
| 7/24-7/29 | 0.97 | 0.64 | 1.02 |
| 8/1-8/3 | 0.42 | 0.91 | 0.53 |
| 8/8 | 0.12 | 0.34 | 0.40 |
| 8/11-8/14 | 0.15 | 0.41 | 0.45 |
| 8/16-8/17 | 0.18 | 0.07 | 0.06 |
| 8/20-8/22 | 0.24 | 0.23 | 0.24 |
| 8/27-8/30 | 0.13 | 0.09 | 0.12 |
| 9/4-9/5 | 0.22 | 0.17 | 0.19 |
| 9/7-9/8 | 0.01 | 0.02 | 0.03 |
| 9/10-9/15 | -- | 2.33 | 2.45 |
| 9/18-9/19 | 0.53 | 0.37 | 0.39 |
| 9/26-9/30 | 1.67 | 1.44 | 1.75 |
| 10/5 | 0.26 | 0.30 | 0.32 |
| 10/7-10/8 | 0.29 | 0.36 | 0.34 |
| 10/13-10/14 | 0.18 | 0.27 | 0.20 |
| 10/19 | 0.03 | 0.06 | 0.04 |
| 10/26-10/27 | 0.37 | 0.46 | 0.38 |
| 10/31-11/2 | -- | 0.65 | 0.78 |
| 11/08-11/11 | 0.31 | 0.48 | 0.46 |
| 11/19 | 0.03 | 0.15 | 0.09 |
| 11/23 | 0.11 | 0.22 | 0.20 |
| 11/29-12/2 | 0.09 | 0.36 | 0.18 |
| 12/8-12/9 | 0.16 | 0.21 | 0.24 |
| 12/13 | 0.08 | 0.17 | 0.15 |
| 12/23-12/24 | 0.13 | 0.43 | 0.24 |
| 12/27 | 0.10 | 0.15 | 0.15 |
| Monthly Total | | | |
| July | 1.19 | 0.92 | 1.32 |
| August | 1.24 | 2.05 | 1.80 |
| September | -- | 4.33 | 4.81 |
| October | -- | 2.10 | 2.06 |
| November | 0.54 | 1.21 | 0.93 |
| December | 0.47 | 0.96 | 0.78 |
| Six-Month Total | -- | 11.57 | 11.70 |

No precipitation was recorded on dates not listed.

APPENDIX 2-2.3

RBOSC Site 2 Precipitation Data (Inches)
July - December 1982

| Date | Weather Measure Tipping Bucket Gauge | Belfort Weighing Bucket Gauge | Wedge Gauge |
|---|---|---|---|
| 7/5 | 0.08 | 0.12 | 0.12 |
| 7/11 | 0.01 | 0.00 | 0.01 |
| 7/13 | 0.05 | 0.04 | 0.05 |
| 7/17 | 0.01 | 0.02 | 0.00 |
| 7/21 | 0.01 | 0.02 | 0.03 |
| 7/24-7/29 | 0.36 | 0.23 | 0.36 |
| 8/1-8/3 | 0.18 | 0.10 | 0.25 |
| 8/8 | 0.51 | 0.60 | 0.57 |
| 8/11-8/14 | 0.20 | 0.16 | 0.28 |
| 8/16-8/17 | 0.20 | 0.10 | 0.24 |
| 8/20-8/22 | 0.61 | 0.73 | 0.58 |
| 8/27-8/30 | 0.01 | 0.02 | 0.02 |
| 9/4-9/5 | 0.26 | 0.34 | 0.26 |
| 9/7-9/8 | 0.01 | 0.02 | 0.00 |
| 9/10-9/15 | 1.90 | 2.29 | 1.95 |
| 9/18-9/19 | 0.30 | 0.39 | 0.40 |
| 9/26-9/30 | 0.93 | 1.13 | 1.14 |
| 10/5 | 0.20 | 0.20 | 0.22 |
| 10/7-10/8 | 0.36 | 0.45 | 0.33 |
| 10/13-10/14 | 0.16 | 0.00 | 0.18 |
| 10/19 | 0.03 | 0.07 | 0.04 |
| 10/26-10/27 | 0.31 | 0.44 | 0.31 |
| 10/31-11/2 | -- | 0.83 | 0.84 |
| 11/10-11/11 | 0.29 | 0.48 | 0.41 |
| 11/19 | 0.02 | 0.07 | 0.03 |
| 11/23 | 0.02 | 0.18 | 0.26 |
| 11/29-12/2 | 0.09 | 0.34 | 0.26 |
| 12/8-12/9 | 0.16 | 0.15 | 0.02 |
| 12/13 | 0.03 | 0.26 | 0.38 |
| 12/23-12/24 | 0.16 | 0.33 | 0.30 |
| 12/27 | 0.15 | 0.24 | 0.20 |
| Monthly Total | | | |
| July | 0.52 | 0.43 | 0.57 |
| August | 1.71 | 1.71 | 1.94 |
| September | 3.40 | 4.17 | 3.75 |
| October | -- | 1.99 | 1.92 |
| November | 0.42 | 1.07 | 0.96 |
| December | 0.50 | 0.98 | 0.90 |
| Six-Month Total | -- | 10.35 | 10.04 |

No precipitation was recorded on dates not listed.

APPENDIX 2-2.3

RBOSC Site 3 Precipitation Data (Inches)
July - December 1982

| Date | Wedge Gauge |
|---|---|
| 7/1 | 0.05 |
| 7/5 | 0.07 |
| 7/13 | 0.06 |
| 7/17 | 0.04 |
| 7/24-7/29 | 0.98 |
| 8/1-8/3 | 0.12 |
| 8/8 | 0.47 |
| 8/11-8/14 | 0.31 |
| 8/16-8/17 | 0.11 |
| 8/20-8/22 | 0.20 |
| 8/27-8/30 | 0.07 |
| 9/4-9/5 | 0.10 |
| 9/7-9/8 | 0.02 |
| 9/10-9/15 | 2.14 |
| 9/18-9/19 | 0.15 |
| 9/26-9/30 | 1.04 |
| 10/7-10/8 | 0.57 |
| 10/13-10/14 | 0.20 |
| 10/19 | 0.04 |
| 10/26-10/27 | 0.32 |
| 10/31-11/2 | 0.61 |
| 11/10-11/11 | 0.33 |
| 11/19 | 0.04 |
| 11/23 | 0.24 |
| 11/29-12/2 | 0.11 |
| 12/8-12/9 | 0.01 |
| 12/13 | 0.30 |
| 12/23-12/24 | 0.27 |
| 12/27 | 0.12 |
| Monthly Total | |
| July | 1.20 |
| August | 1.28 |
| September | 3.45 |
| October | 1.74 |
| November | 0.72 |
| December | 0.70 |
| Six-Month Total | 9.09 |

No precipitation was recorded on dates not listed.

# APPENDIX 2-2.4

## Snow Depth Data

APPENDIX 2-2.4

Snow Depth Measurements (Inches)
January - December 1982

| Date | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| 1/02 | 11 | 9 | 9 |
| 1/04 | 10 | --- | 9 |
| 1/05 | 10 | 9 | 10 |
| 1/07 | 9 | 6 | 10 |
| 1/08 | 9 | --- | 10 |
| 1/11 | 9 | 5.5 | 10 |
| 1/12 | 9.5 | --- | 10 |
| 1/13 | 9 | 6 | 9.5 |
| 1/14 | 9 | --- | 9 |
| 1/15 | 8.5 | 5 | 8.5 |
| 1/16 | 8 | 5 | 8 |
| 1/18 | 7.5 | 5 | 7.5 |
| 1/19 | 7.5 | 5 | 7 |
| 1/20 | 7.5 | 5 | 7 |
| 1/21 | 8 | --- | 7 |
| 1/22 | 11 | 10 | 12 |
| 1/25 | 11 | 9.5 | 11 |
| 1/26 | 10 | 9 | 10 |
| 1/27 | 9.5 | 8 | 10 |
| 1/28 | 9 | --- | 9 |
| 1/29 | 7 | 6 | 7 |
| 2/01 | 9 | 8 | 10 |
| 2/02 | 10 | 9 | 10 |
| 2/03 | 10 | 9.5 | 10 |
| 2/04 | 12 | 10 | 10.5 |
| 2/05 | 12 | 10 | 10.5 |
| 2/06 | 12 | 10 | 10.5 |
| 2/08 | 12 | 10.5 | 10.5 |
| 2/09 | 12 | 10.5 | 10 |
| 2/10 | 12 | 10 | 10 |
| 2/11 | 12 | 10 | 10 |
| 2/12 | 11.5 | --- | 9.5 |
| 2/15 | 10 | 8 | 9 |
| 2/16 | 9 | --- | 7 |
| 2/17 | 9 | 7 | 7 |
| 2/18 | 8.5 | --- | 6 |
| 2/19 | 8 | 6.5 | 6 |
| 2/22 | 6.5 | patches | patches |
| 2/23 | 6 | patches | patches |
| 2/24 | 4 | --- | patches |
| 2/25 | 4 | patches | patches |
| 2/26 | patches | --- | 0 |
| 2/27 | patches | patches | 0 |
| 3/01 | patches | patches | 0 |
| 3/02 | patches | patches | 0 |

APPENDIX 2-2.4 (Continued)

| Date | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| 3/03 | 2 | --- | 0 |
| 3/04 | 3 | 3 | 2 |
| 3/05 | 2.5 | 4 | 1 |
| 3/08 | 2 | patches | patches |
| 3/09 | patches | patches | 0 |
| 3/10 | patches | --- | 0 |
| 3/11 | patches | patches | 0 |
| 3/12 | patches | patches | trace |
| 3/15 | .5 | 0 | 0 |
| 3/16 | 0 | 0 | 0 |
| 3/17 | 3 | 1 | 2 |
| 3/19 | 1-2 | patches | patches |
| 3/20 | patches | patches | 0 |
| 3/22 | patches | few patches | 0 |
| 3/23 | patches | few patches | 0 |
| 3/24 | patches | --- | 0 |
| 3/25 | patches | --- | 0 |
| 3/26 | few patches | 0 | 0 |
| 3/29 | 2 | .5 | patches |
| 3/30 | 1 | patches | patches |
| 3/31 | 1 | --- | patches |
| 4/01 | 0 | 0 | 0 |
| 4/02 | 3 | 1 | --- |
| 4/05 | few patches | 0 | --- |
| 4/06 | few patches | 0 | --- |
| 4/07 | 2 | 2 | --- |
| 4/08 | 1 | --- | --- |
| 4/11 | 0 | 0 | 0 |
| | No snowcover measured after 4/11/82 | | |
| | No snowcover measured before 10/05/82 | | |
| 10/05 | 3 | --- | --- |
| 10/06 | 1-3 | trace | 0 |
| 10/07 | 0 | 0 | 0 |
| 10/08 | 4 | --- | --- |
| 10/11 | 0 | 0 | --- |
| 10/12 | 0 | --- | --- |
| 10/13 | 1 | patches | .5 |
| 10/14 | 0 | --- | 0 |
| 10/15 | 0 | 0 | 0 |
| 10/17 | 0 | --- | 0 |
| 10/18 | 0 | --- | --- |
| 10/19 | 1 | patches | patches |
| 10/20 | 0 | 0 | --- |
| 10/22 | 0 | 0 | 0 |
| 10/25 | 0 | 0 | 0 |
| 10/26 | 0 | 0 | 0 |
| 10/27 | 4 | --- | 5 |

APPENDIX 2-2.4 (Continued)

| Date | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| 10/28 | 3 | --- | --- |
| 10/29 | patches | patches | patches |
| 11/01 | 0 | 0 | 0 |
| 11/02 | 2 | 1 | 2 |
| 11/03 | patches | patches | patches |
| 11/04 | patches | patches | patches |
| 11/05 | patches | patches | patches |
| 11/07 | 0 | 0 | 0 |
| 11/08 | 0 | 0 | --- |
| 11/09 | 0 | 0 | --- |
| 11/10 | 0 | --- | 0 |
| 11/11 | 5 | 4 | 2 |
| 11/13 | 4 | 3 | 1 |
| 11/15 | 3 | 2 | patches |
| 11/16 | 3 | 2 | --- |
| 11/17 | 3 | 2 | patches |
| 11/18 | 2.5 | 2 | patches |
| 11/19 | patches | 2 | patches |
| 11/22 | 1 | 1 | patches |
| 11/23 | 3 | --- | --- |
| 11/24 | 3 | 3 | 2 |
| 11/25 | 3 | --- | --- |
| 11/27 | 3 | 3 | 2 |
| 11/29 | 2 | 3 | 2 |
| 11/30 | 2 | 3 | 2.5 |
| 12/01 | 4.5 | 4 | 2.5 |
| 12/02 | 5 | 4.5 | 2.5 |
| 12/03 | 5 | 5 | 2.5 |
| 12/06 | 5 | 5 | 3 |
| 12/07 | 5 | 3 | 1 |
| 12/08 | 5 | --- | --- |
| 12/09 | 5 | 3 | 1 |
| 12/10 | 5 | --- | --- |
| 12/13 | 5 | --- | --- |
| 12/14 | 8 | 7 | 3 |
| 12/15 | 8 | 7 | 3 |
| 12/16 | 8 | --- | 3 |
| 12/17 | 8 | 7 | 3 |
| 12/20 | 7.5 | 6.5 | 2.5 |
| 12/21 | 7 | 6 | 2.5 |
| 12/22 | 5 | 4 | 2 |
| 12/25 | 7 | 3 | 3 |
| 12/28 | 10 | 7 | 4 |
| 12/29 | 10 | --- | --- |
| 12/30 | 10 | 6 | 4 |

Snow depths given only on days when measurements were taken

# APPENDIX 2-2.5

## Barometric Pressure Data

APPENDIX 2-2.5
Barometric Pressure (mm Hg)
Site 1
January - March 1982

| Date | Barometric Pressure | Date | Barometric Pressure | Date | Barometric Pressure |
|---|---|---|---|---|---|
| 1/02 | 568.0 | 2/01 | 581.8 | 3/01 | 586.6 |
| 1/04 | 578.9 | 2/02 | 582.1 | 3/02 | 577.8 |
| 1/05 | 572.0 | 2/03 | 576.1 | 3/03 | 576.8 |
| 1/06 | 577.3 | 2/04 | 576.4 | 3/04 | 576.8 |
| 1/07 | 588.3 | 2/05 | 583.7 | 3/04 | 581.7 |
| 1/08 | 589.4 | 2/06 | 587.3 | 3/08 | 582.9 |
| 1/11 | 577.1 | 2/08 | 575.8 | 3/09 | 585.3 |
| 1/12 | 579.4 | 2/09 | 577.7 | 3/10 | 583.4 |
| 1/13 | 582.8 | 2/10 | 579.3 | 3/11 | 576.9 |
| 1/14 | 582.8 | 2/11 | 579.8 | 3/12 | 578.0 |
| 1/15 | 580.9 | 2/12 | 589.6 | 3/15 | 572.1 |
| 1/16 | 582.7 | 2/15 | 582.5 | 3/16 | 575.4 |
| 1/18 | 581.7 | 2/16 | 582.0 | 3/17 | 578.9 |
| 1/19 | 575.5 | 2/17 | 582.1 | 3/19 | 577.1 |
| 1/20 | 577.4 | 2/18 | 585.8 | 3/20 | 581.4 |
| 1/21 | 570.9 | 2/19 | 587.6 | 3/22 | 583.1 |
| 1/22 | 577.6 | 2/22 | 584.0 | 3/23 | 579.5 |
| 1/25 | 585.3 | 2/23 | 580.9 | 3/24 | 579.0 |
| 1/26 | 581.7 | 2/24 | 584.3 | 3/25 | 582.9 |
| 1/27 | 583.3 | 2/25 | 584.5 | 3/26 | 578.3 |
| 1/28 | 580.6 | 2/26 | 584.0 | 3/29 | 568.7 |
| 1/29 | 578.3 | 2/27 | 584.6 | 3/30 | 575.3 |
| | | | | 3/31 | 580.7 |

Days are listed only when measurements were taken

APPENDIX 2-2.5
Barometric Pressure (mm Hg)
Site 1
April - June 1982

| Date | Barometric Pressure | Date | Barometric Pressure | Date | Barometric Pressure |
|---|---|---|---|---|---|
| 4/01 | 574.5 | 5/01 | 585.3 | 6/01 | 578.1 |
| 4/02 | 578.2 | 5/03 | 581.9 | 6/02 | 581.4 |
| 4/05 | 583.4 | 5/04 | 582.3 | 6/03 | 581.8 |
| 4/06 | 574.1 | 5/05 | 584.0 | 6/04 | 579.1 |
| 4/07 | 576.9 | 5/07 | 584.1 | 6/07 | 582.7 |
| 4/08 | 580.8 | 5/10 | 576.7 | 6/09 | 585.8 |
| 4/11 | 581.9 | 5/11 | 577.9 | 6/10 | 584.4 |
| 4/12 | 580.6 | 5/12 | 577.1 | 6/11 | 583.4 |
| 4/13 | 582.3 | 5/13 | 579.9 | 6/12 | 582.0 |
| 4/14 | 578.8 | 5/14 | 583.7 | 6/14 | 581.0 |
| 4/15 | 577.8 | 5/17 | 583.4 | 6/15 | 584.3 |
| 4/16 | 583.3 | 5/18 | 579.7 | 6/16 | 584.1 |
| 4/19 | 584.2 | 5/19 | 580.4 | 6/17 | 582.9 |
| 4/20 | 586.4 | 5/20 | 585.3 | 6/18 | 584.4 |
| 4/21 | 588.4 | 5/21 | 585.6 | 6/21 | 585.6 |
| 4/22 | 588.4 | 5/13 | 583.0 | 6/22 | 586.2 |
| 4/23 | 585.6 | 5/24 | 584.6 | 6/25 | 584.3 |
| 4/26 | 584.0 | 5/25 | 581.6 | 6/28 | 583.1 |
| 4/27 | 583.4 | 5/26 | 580.8 | 6/29 | 583.9 |
| 4/28 | 584.2 | 5/31 | 584.6 | 6/30 | 584.4 |
| 4/29 | 583.0 | | | | |
| 4/30 | 585.2 | | | | |

Days are listed only when measurements were taken

APPENDIX 2-2.5
Barometric Pressure (mm Hg)
Site 1
July - September 1982

| Date | Barometric Pressure | Date | Barometric Pressure | Date | Barometric Pressure |
|---|---|---|---|---|---|
| 7/01 | 583.0 | 8/02 | 584.6 | 9/01 | 590.0 |
| 7/02 | 585.9 | 8/03 | 585.9 | 9/02 | 591.4 |
| 7/03 | 586.3 | 8/04 | 586.8 | 9/03 | 589.0 |
| 7/06 | 586.4 | 8/06 | 591.3 | 9/04 | 587.1 |
| 7/07 | 586.3 | 8/10 | 588.3 | 9/06 | 588.7 |
| 7/08 | 585.0 | 8/11 | 587.4 | 9/07 | 589.7 |
| 7/09 | 586.1 | 8/12 | 587.1 | 9/09 | 587.1 |
| 7/12 | 587.9 | 8/13 | 586.1 | 9/10 | 581.7 |
| 7/13 | 587.2 | 8/14 | 586.7 | 9/11 | 581.7 |
| 7/14 | 585.1 | 8/16 | 590.0 | 9/13 | 579.2 |
| 7/15 | 583.2 | 8/17 | 590.2 | 9/14 | 585.7 |
| 7/16 | 584.5 | 8/18 | 589.2 | 9/15 | 584.5 |
| 7/19 | 586.7 | 8/19 | 589.0 | 9/16 | 584.3 |
| 7/20 | 586.5 | 8/20 | 592.3 | 9/17 | 586.3 |
| 7/22 | 587.4 | 8/23 | 587.3 | 9/20 | 586.5 |
| 7/23 | 588.5 | 8/24 | 587.5 | 9/21 | 587.1 |
| 7/26 | 588.5 | 8/25 | 586.9 | 9/22 | 586.2 |
| 7/27 | 588.9 | 8/26 | 586.3 | 9/23 | 587.0 |
| 7/28 | 588.1 | 8/27 | 588.3 | 9/24 | 587.6 |
| 7/29 | 587.6 | 8/30 | 587.6 | 9/26 | 579.6 |
| | | 8/31 | 588.2 | 9/27 | 574.7 |
| | | | | 9/29 | 577.9 |
| | | | | 9/30 | 577.5 |

Days are listed only when measurements were taken

APPENDIX 2-2.5
Barometric Pressure (mm Hg)
Site 1
October - December 1982

| Date | Barometric Pressure | Date | Barometric Pressure | Date | Barometric Pressure |
|---|---|---|---|---|---|
| 10/01 | 581.7 | 11/01 | 584.5 | 12/01 | 564.7 |
| 10/04 | 580.4 | 11/02 | 586.6 | 12/02 | 576.0 |
| 10/05 | 581.8 | 11/03 | 587.8 | 12/03 | 584.9 |
| 10/06 | 586.3 | 11/04 | 586.7 | 12/06 | 581.4 |
| 10/07 | 578.8 | 11/05 | 584.7 | 12/07 | 580.3 |
| 10/08 | 581.8 | 11/07 | 579.8 | 12/08 | 589.5 |
| 10/11 | 584.7 | 11/08 | 577.8 | 12/09 | 585.8 |
| 10/12 | 587.6 | 11/09 | 580.0 | 12/10 | 581.0 |
| 10/13 | 587.9 | 11/10 | 580.4 | 12/13 | 575.6 |
| 10/14 | 589.1 | 11/11 | 579.1 | 12/14 | 582.6 |
| 10/15 | 590.5 | 11/13 | 578.9 | 12/15 | 585.2 |
| 10/17 | 582.4 | 11/15 | 584.4 | 12/16 | 587.9 |
| 10/18 | 581.6 | 11/16 | 582.1 | 12/17 | 582.0 |
| 10/19 | 588.8 | 11/17 | 580.6 | 12/18 | 586.7 |
| 10/20 | 585.3 | 11/18 | 576.6 | 12/20 | 582.0 |
| 10/21 | 588.4 | 11/19 | 574.2 | 12/21 | 580.8 |
| 10/22 | 589.2 | 11/22 | 579.9 | 12/22 | 578.4 |
| 10/25 | 583.7 | 11/23 | 585.3 | 12/25 | 587.8 |
| 10/26 | 582.6 | 11/24 | 579.0 | 12/28 | 583.6 |
| 10/27 | 581.0 | 11/27 | 583.6 | 12/29 | 579.7 |
| 10/28 | 584.4 | 11/29 | 574.3 | 12/30 | 581.9 |
| 10/29 | 581.8 | 11/30 | 567.1 | | |

Days are listed only when measurements were taken

# APPENDIX 2-6

## Visibility Data

APPENDIX 2-6.1

Hourly Visual Range Data - Spring 1982

Hourly Visual Range Data (miles)
Spring 1982, Piceance Creek Basin, Colorado

| Date | View | TIME 0830 | 0930 | 1030 | 1130 | 1300 | 1400 | 1500 | Mean | Daily Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| May 3 | I | 79 | 95 | 91 | 96 | 106 | 100 | 93 | 94 | |
| | II | 79 | 89 | 98 | 96 | 101 | 101 | 99 | 95 | |
| | III | 88 | 94 | 104 | 104 | 106 | 100 | 98 | 99 | |
| | IV | 93 | 95 | 108 | 98 | 100 | 100 | 101 | 99 | 97 |
| May 7 | I | 166 | 171 | 174 | 172 | 165 | 164 | 168 | 169 | |
| | II | 167 | 169 | 170 | -- | 162 | 166 | 164 | 167 | |
| | III | 179 | 180 | 183 | 174 | 175 | 178 | 171 | 177 | |
| | IV | 193 | 191 | 180 | 177 | 172 | 179 | 177 | 182 | 174 |
| May 11 | I | -- | 84 | 82 | 80 | -- | 76 | -- | 81 | |
| | II | -- | 80 | 74 | -- | -- | -- | -- | -- | |
| | III | -- | 75 | 64 | 71 | 62 | 66 | -- | 68 | |
| | IV | -- | -- | 80 | -- | 63 | 85 | -- | 76 | 75 |
| May 19 | I | 73 | -- | 101 | 89 | 96 | 100 | -- | 92 | |
| | II | 70 | 94 | 83 | 80 | 90 | -- | 86 | 84 | |
| | III | 58 | 56 | 86 | 71 | 82 | 89 | 90 | 76 | |
| | IV | 76 | 78 | 93 | 93 | 104 | 99 | 98 | 92 | 86 |
| May 23 | I | 89 | 95 | 100 | 104 | 105 | 112 | 106 | 102 | |
| | II | 92 | 96 | 106 | 108 | 104 | 111 | 113 | 104 | |
| | III | 102 | 105 | 109 | 102 | 106 | 110 | 109 | 106 | |
| | IV | 102 | 105 | 109 | 114 | 113 | 118 | 115 | 111 | 106 |
| May 27 | I | 110 | 118 | 109 | 113 | 111 | 117 | 111 | 113 | |
| | II | 92 | 106 | 113 | 107 | 100 | 103 | 102 | 103 | |
| | III | 99 | 110 | 107 | 107 | 107 | 114 | 114 | 108 | |
| | IV | 102 | 108 | 103 | 97 | 112 | 119 | 114 | 108 | 108 |
| June 4 | I | 119 | 113 | 118 | 118 | 115 | 132 | 123 | 120 | |
| | II | 103 | 109 | 110 | 115 | 111 | 114 | 122 | 112 | |
| | III | 102 | 111 | 114 | 115 | 112 | 118 | 118 | 113 | |
| | IV | 104 | 122 | 115 | 118 | 125 | 122 | 119 | 118 | 116 |
| June 8 | I | -- | 112 | 111 | 120 | 120 | 109 | 114 | 114 | |
| | II | 99 | 108 | 95 | 112 | 106 | 105 | 103 | 104 | |
| | III | 94 | 109 | 113 | 112 | 109 | 98 | 110 | 107 | |
| | IV | 107 | 109 | 113 | 124 | 128 | 114 | 120 | 117 | 110 |
| June 12 | I | 112 | 122 | 127 | 115 | 117 | 118 | 118 | 119 | |
| | II | 101 | 114 | 114 | 112 | 116 | 109 | 112 | 111 | |
| | III | 99 | 126 | 119 | 115 | 120 | 125 | 119 | 118 | |
| | IV | 108 | 123 | 131 | 131 | 136 | 125 | 125 | 126 | 118 |
| June 16 | I | 96 | 106 | 110 | 112 | 105 | 110 | 110 | 107 | |
| | II | 97 | 90 | 102 | 103 | 104 | 101 | 104 | 100 | |
| | III | 89 | 99 | 98 | 117 | 104 | 98 | 106 | 102 | |
| | IV | 100 | 96 | 110 | 113 | 110 | 119 | 110 | 108 | 104 |

APPENDIX 2-6.2

Visibility Site Log Sheets - Spring 1982

# SITE LOG SHEETS

5/3/82

MDT

0830: 11°C. 85% cloud cover - cumulus all levels. Some cirrus to the NE, status to the NW. Very bright behind View 4 - Pt. 9 barely distinguishable. Wind easterly, 0-7 mph.

0930: 11°C. Same conditions - Pt. 9 more visible. Wind picking up-gusty from south 3-15 mph. Clouds on horizon behind all views.

1030: 14°C. 75% cloud cover. Mostly sunny overhead. Cumulus, all levels - solid above all views. Wind gusty & variable 5-20 mph.

1130: 15°C. 45% cloud cover. Mid & low level cumulus over entire horizon. Mostly sunny overhead with some cirrus. Wind still gusty & variable 5-20 mph.

1300: 16°C. 50% cloud cover. Scattered cumulus all levels. Raining at Pt. 1 - had to take Pt. 0 reading. Clouds at horizon on all views. Wind from south, avg. 10 mph.

1400: 18°C. 50% cloud cover - scattered cumulus - horizon still solid clouds. Mostly sunny overhead. Wind southerly, avg. 8 mph.

1500: 17°C. 40% cloud cover - scattered cumulus, all levels. Wind from south, avg. 8 mph.

# SITE LOG SHEETS

5/7/82

MDT

0830: 10°C. Cool, clouds on northern and eastern horizons; Some haze N&E; Partly cloudy (high cirrus); mostly calm. View #4 still covered with snow (top).

0930: 11°C. Cool, scattered clouds, some obscuring of sun from high clouds. Light winds, variable.

1030: 10°C. Some low cumulus moving in, partly coudy. 30% cloud cover, scattered high cirrus also. Light (3-5 mph) S, SW winds. Some haze (easterly) still.

1130: 12°C. 60% cloud cover. Winds 8-12 mph, W, SW. All points visible.

1300: 12°C. 80% cloud cover. Winds 10-12 mph, S, SE. Cool - all points visible.

1400: 14°C. Winds 5-6 mph, from W, SW. 75-80% cloud cover. All points visible. Some scattered showers.

1500: 13°C. Winds 10-15 mph, N, W, SW. 75% cloud cover, mostly cumulus. Some thundershowers moving in from W, SW. View #9 barely visible due to showers.

# SITE LOG SHEETS

5/11/82

MDT

0830: 4°C. No points visible. 100% cloud cover - raining or snowing just about everywhere. Calm.

0930: 5°C. 50% cloud cover - low and mid level cumulus to North, East & South. Sunny overhead. Slight breeze from SE.

1030: 9°C. 95% cloud cover - cumulus, all levels. Cloud covering point 5. Wind avg. 5 mph from SE.

1130: 5°C. 90% cloud cover - some sun overhead - cumulus on all horizons - snowing to the N, NE. View IV not visible. Wind SE, avg. 5 mph.

1300: 4°C. 90% cloud cover - solid to the East & North. Snowing at Views I & II. Wind from SE avg. 5 mph.

1400: 9°C. 95% cloud cover - snowing here. Grey, solid clouds to the North. Cumulus all levels to the West. Wind gusty - up to 15 mph from SE.

1500: 5°C. 60% cloud cover - solid bank to the North & on horizon to the West & East. Sunny overhead. Wind from SE avg. 5 mph.

# SITE LOG SHEETS

5/19/82

MDT

0830: 7°C. 70% cloud cover - heavy duty storm coming from the West. Cloudy overhead - partly cloudy to the North & East (cumulus) West wind avg. 8 mph.

0930: 6°C. 100% cloud cover, sprinkling here. Dark to the W, NW & South. Bright clouds behind Views III & IV. Wind westerly avg. 12 mph.

1030: 8°C. 100% cloud cover - grey out - especially at View 3 and to the East. Low light cumulus at View 2. Wind avg. 10 mph from South.

1130: 8°C. 90% cloud cover - some clearing to the SW - Rest total grey sky. Wind from SE, gusty, avg. 10 mph. Points 1 & 8 barely visible.

1300: 15°C. 95% cloud cover. Cumulus all levels. Dark clouds overhead. Fairly light on horizon behind all views. Wind southerly, avg. 8 mph.

1400: 12°C. 90% cloud cover. Cumulus, all levels. Some sun overhead & light clouds. Raining at View 2, and View 4, somewhat gusty wind from West, avg. 15 mph.

1500: 10°C. 100% cloud cover. Raining in most directions. Southwesterly wind, avg. 10 mph. View I not visible.

# SITE LOG SHEETS

5/23/82

MDT

0830: 13°C. 50% cloud cover - cumulus. Stratus to the NE. Grey cirrus to the North - Northwest. Sunny overhead. Wind avg. 6 mph from NW.

0930: 13°C. 60% cloud cover. Grey cirrus & cumulus to North & West. Partly sunny overhead. Clouds on horizon behind all views. Wind avg. 6 mph from NW.

1030: 15°C. 60% cloud cover. Cumulus & stratus to North & West all levels. Partly sunny overhead. Wind from North Avg. 8 mph. Point 1 barely visible.

1130: 15°C. 40% cloud cover - scattered cumulus. High cirrus to the NW. Sunny overhead. Wind from North, avg. 6 mph.

1300: 16°C. 50% cloud cover - scattered cumulus, all levels. Mostly sunny overhead. Wind westerly, avg. 5 mph.

1400: 18°C. 40% cloud cover - scattered cumulus to the West, North & East. Sunny overhead. Wind avg. 5 mph from west.

1500: 17°C. 50% cloud cover - scattered cumulus, all levels. Sunny overhead. Westerly wind avg. 8 mph.

# SITE LOG SHEETS

5/27/82

MDT

0830: 16°C. 50% cloud cover - scattered cirrus, some cumulus to the NW. Cirrus on horizon behind all views. Sunny overhead. Wind SE, avg. 8 mph

0930: 18°C. 40% cloud cover - mostly cirrus & cumulus to NW. Wind gusty from SE. Mostly sunny overhead.

1030: 19°C. 40% cloud cover - scattered cirrus & cumulus - clouds on horizon behind all views. Sunny overhead. Wind conditions the same.

1130: 21°C. 40% cloud cover - mid-level cumulus - all directions & cirrus all directions. Sunny overhead. Wind gusty from SE avg. 10 mph.

1300: 22°C. 35% cloud cover - scattered cumulus, all levels - sunny overhead. Wind southerly, gust to 20 mph.

1400: 23°C. 60% cloud cover - cumulus all levels, all directions. Raining off to the west & some to the NW - around View I. Mostly sunny overhead. Wind same.

1500: 21°C. 80% cloud cover - scattered cumulus, all levels. Raining to the West to North. Point 1 barely visible. Some sun overhead. Wind gusty from SSE - avg. 12 mph.

# SITE LOG SHEETS

6/4/82

MDT

0830: 14°C. No clouds, some slight haze on horizon, but all farthest points perfectly visible. Gusty wind from South, avg. 8 mph.

0930: 15°C. Same conditions.

1030: 17°C. 2% cloud cover - small, puffy cumulus, mid & low level from North to East. Slight haze. Wind avg. 12 mph from South.

1130: 18°C. 5% cloud cover - more scattered cumulus. Sunny overhead. Wind avg. 15 mph from South.

1300: 20°C. 10% cloud cover -scattered cumulus, all levels. Wind conditions the same. Sunny overhead.

1400: 21°C. 15% cloud cover - scatterd cumulus, mostly sunny overhead. Very windy, from the south avg. 16 mph.

1500: 21°C. 20% cloud cover - same cloud & wind conditions. Horizon more hazy.

# SITE LOG SHEETS

6/8/82

MDT

0830: 10°C. Clear. Wind from NW, avg. 5 mph. Horizon slightly hazy.

0930: 11°C. Same conditions.

1030: 14°C. 2% cloud cover - low & mid level cumulus, scattered. Wind from North, avg. 6 mph. Horizon slightly hazy.

1130: 14°C. 10% cloud cover - scattered cumulus, all levels. Mostly sunny overhead. Wind NW, avg. 8 mph.

1300: 17°C. 20% cloud cover - scattered cumulus, all levels. Horizon slightly hazy. Winds occasionally gusty - up to 15 mph from West.

1400: 18°C. 55% cloud cover - scattered cumulus, all levels. Partly sunny overhead. Wind really gusty - up to 20 mph from West.

1500: 19°C. 70% cloud cover - scattered cumulus, all levels. Cloudy overhead. Wind from West, avg. 10 mph.

# SITE LOG SHEETS

6/12/82

MDT

0830: 17°C. 90% cloud cover - cirrus & scattered cumulus. Scattered rain to the East. All farthest points quite clear, clouds behind all views, calm.

0930: 21°C. 75% cloud cover - mostly cirrus, still raining to the East. Sunny overhead. Slight occasional breeze - variable.

1030: 23°C. 90% cloud cover - cirrus & cumulus. Some darker rain clouds to the NW & N. Slight breeze - variable.

1130: 23°C. 80% cloud cover - cirrus & scattered cumulus - solid clouds on horizon. Slight breeze from south. Partly sunny overhead.

1300: 25°C. 90% cloud cover - thin cirrus overhead. Cumulonimbus - Raining at View 4 - Point 9 barely visible. Grey cirrus to the North. Wind avg. 4 mph from South.

1400: 24°C. 95% cloud cover, scattered cumulus & cirrus. Some sun overhead. Raining to the NE. Wind getting gusty from South. Avg. 6 mph.

1500: 25°C. 100% cloud cover. Grey rain clouds to the NW & NE. Scattered cumulus, all levels. Wind southerly, avg. 6 mph.

# SITE LOG SHEETS

6/16/82

MDT

0830: 15°C. 1% cloud cover - cumulus on horizon behind View 4. Occasional slight breeze - variable.

0930: 16°C. 7% cloud cover - scattered, low level cumulus. Sunny overhead. Slight occasional breeze from North.

1030: 17°C. 15% cloud cover - scattered mid & low level cumulus. Clouds on horizon behind Views 3 & 4. Sunny overhead. Wind 0-5 mph from West.

1130: 19°C. 30% cloud cover - scattered cumulus, all levels. Horizon slightly hazy. Shadows making the telephotometer readings unstable - taking average. Wind avg. 4 mph from West.

1300: 18°C. 60% cloud cover - scattered cumulus, all levels. Grey cloud overhead. Wind from West, avg. 5 mph.

1400: 21°C. 60% cloud cover - same conditions.

1500: 24°C. 60% cloud cover - scattered cumulus, all levels. Mostly sunny overhead. Wind conditions the same.

APPENDIX 2-6.3

Hourly Visual Range Data - Fall 1982

Appendix 2-6.3

Hourly Visual Range Data (miles)
Fall 1982, Piceance Creek Basin, Colorado

| Date | View | TIME 0830 | 0930 | 1030 | 1130 | 1300 | 1400 | 1500 | Mean | Daily Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| September 4 | I | 55 | 97 | 103 | 90 | 88 | 85 | 73 | 85 | |
| | II | 60 | 91 | 80 | 88 | 90 | 73 | 68 | 79 | |
| | III | 55 | 78 | 82 | 82 | 79 | 72 | 68 | 74 | |
| | IV | 85 | 107 | 104 | 90 | 96 | 68 | 66 | 88 | 81 |
| September 16 | I | 64 | 72 | 73 | 80 | 78 | 81 | 82 | 76 | |
| | II | 69 | 72 | 76 | 78 | 78 | 82 | 80 | 77 | |
| | III | 64 | 66 | 73 | 77 | 82 | 85 | 77 | 75 | |
| | IV | 74 | 71 | 67 | 82 | 83 | 90 | 83 | 79 | 76 |
| September 20 | I | -- | -- | 66 | 72 | 72 | 74 | 70 | 71 | |
| | II | -- | -- | 64 | 72 | 73 | 74 | 83 | 73 | |
| | III | -- | -- | 60 | 60 | 63 | 68 | 66 | 64 | |
| | IV | -- | -- | 68 | 69 | 72 | 86 | 74 | 74 | 70 |
| September 24 | I | 73 | 78 | 81 | 92 | 92 | 95 | 86 | 85 | |
| | II | 72 | 84 | 88 | 88 | 89 | 89 | 82 | 85 | |
| | III | 68 | 85 | 89 | 91 | 89 | 85 | 82 | 84 | |
| | IV | 85 | 84 | 83 | 91 | 94 | 89 | 78 | 86 | 85 |
| October 2 | I | 55 | 74 | 76 | -- | 71 | 75 | 70 | 70 | |
| | II | 55 | 60 | 69 | -- | 71 | 79 | 73 | 68 | |
| | III | 57 | 64 | 65 | -- | 68 | 73 | 73 | 67 | |
| | IV | 73 | 95 | 68 | 64 | 67 | 68 | 71 | 72 | 69 |
| October 6 | I | -- | -- | -- | -- | 80 | 77 | 72 | 76 | |
| | II | -- | -- | -- | -- | 79 | 77 | 75 | 77 | |
| | III | 70 | 74 | -- | -- | 79 | 80 | 77 | 76 | |
| | IV | 76 | 76 | 75 | 85 | 79 | 79 | 80 | 79 | 77 |
| October 10 | I | 54 | 67 | 71 | -- | 72 | 76 | 68 | 68 | |
| | II | 54 | 65 | 61 | -- | 69 | 75 | 73 | 66 | |
| | III | 56 | 64 | 68 | 70 | 73 | 77 | 78 | 70 | |
| | IV | 65 | 74 | 72 | 86 | 79 | 79 | 79 | 76 | 70 |
| October 14 | I | 69 | 75 | 79 | -- | 80 | 85 | 82 | 78 | |
| | II | 69 | 71 | 73 | 85 | 83 | 82 | 81 | 78 | |
| | III | 66 | 84 | 75 | 86 | 76 | 85 | 83 | 79 | |
| | IV | 69 | 77 | 78 | 81 | 88 | 90 | 85 | 81 | 79 |
| October 18 | I | 56 | 68 | 73 | -- | 80 | 78 | 100 | 76 | |
| | II | 57 | 75 | 74 | 82 | 82 | 88 | 105 | 81 | |
| | III | 55 | 78 | 66 | 73 | 79 | 88 | 106 | 78 | |
| | IV | 71 | 78 | 73 | 74 | 74 | 99 | 78 | 78 | 78 |
| October 22 | I | 54 | 77 | 78 | 74 | 64 | 67 | 82 | 71 | |
| | II | 74 | 75 | 76 | 79 | 60 | 85 | 80 | 76 | |
| | III | 74 | 79 | 69 | 72 | 54 | 77 | 94 | 74 | |
| | IV | 74 | 68 | 77 | 86 | 57 | 79 | 68 | 73 | 73 |

APPENDIX 2-6.4

Visibility Site Log Sheets - Fall 1982

# SITE LOG SHEETS

9/04/82

MDT

0830: 19°C. 40% cloud cover stratus to North & Northeast, scattered cumulus. Clear overhead. Gusty winds from Southwest, avg. 10 mph. Cloudy behind all farthest targets.

0930: 22°C. 60% cloud cover - scattered cumulus & stratus. Cloudy overhead. Wind conditions same.

1030: 23°C. 30% cloud cover - scattered cumulus, mostly to the East. Wind same. Sunny overhead.

1130: 24°C. 40% cloud cover - scattered cumulus. Sunny overhead. SW wind, avg. 12 mph.

1300: 27°C. 60% cloud cover - scattered cumulus. Raining to the NW. Point 9 barely visible - hazy. Sunny overhead. Wind same.

1400: 26°C. 70% cloud cover - scattered cumulus. Raining to the North. Really windy - avg. 15 mph from SW.

1500: 25°C. 80% cloud cover - scattered cumulus, cloudy overhead - still very windy. Raining at Flattops.

# SITE LOG SHEETS

9/16/82

MDT

0830: 9°C. 50% cloud cover. Scattered cumulus & stratus on horizon behind all targets. Dark, solid cumulus to the East. Calm.

0930: 12°C. 50% cloud cover - same conditions, only slight breeze from SE.

1030: 14°C. 35% cloud cover - scattered cumulus & stratus. Wind avg. 5 mph from South.

1130: 17°C. 25% cloud cover - scattered cumulus & stratus on horizon behind all targets. Sunny overhead. Wind gusty from South - up to 20 mph.

1300: 18°C. 40% cloud cover - scattered cumulus & cirrus. Some stratus to the North & West. Sunny overhead. Wind gusty from South - up to 20 mph.

1400: 18°C. 25% cloud cover - scattered cumulus & cirrus. Bright cumulus on horizon behind Target IV. Wind conditions same. Sunny overhead.

1500: 19°C. 60% cloud cover - cirrus & cumulus. Some sun overhead. Gusty wind from South - up to 18 mph.

# SITE LOG SHEETS

9/20/82

MDT

0830: $7^{o}C$. Overcast, raining. View IV not visible at all. Light on horizon to the North and NE. Mostly calm with occasional gusts from the West.

0930: $9^{o}C$. 75% cloud cover - clearing to the West. Raining at Flattops, cloudy at all other targets. Calm.

1030: $12^{o}C$. 40% cloud cover. Scattered cumulus & cirrus. Sunny overhead. Slight breeze from South.

1130: $13^{o}C$. 30% cloud cover - scattered cumulus, sunny overhead. Wind avg. 4 mph from SE.

1300: $16^{o}C$. 30% cloud cover - scattered cumulus; stratus to the east above View IV. Sunny overhead. Winds avg. 5 mph from South.

1400: $17^{o}C$. 30% cloud cover - scattered cumulus, sunny overhead. Wind avg. 6 mph from South.

1500: $18^{o}C$. 35% cloud cover - scattered cumulus, sunny overhead. Wind avg. 7 mph from South.

# SITE LOG SHEETS

9/24/82

MDT

0830: 12°C. 2% cloud cover - some cirrus & stratus to the SW & SE. Clear at all views. Calm.

0930: 13°C. Same conditions.

1030: 15°C. 5% cloud cover - cirrus to the South, stratus to the North. Clouds on horizon behind Views I & II. Slight breeze from SW.

1130: 17°C. Same conditions.

1300: 19°C. 40% cloud cover - scattered cirrus & cumulus. Stratus to the North & East. Westerly wind, avg. 4 mph.

1400: 21°C. 60% cloud cover - scattered cirrus & stratus. Clouds on horizon behind all views. Partly sunny overhead. Westerly wind avg. 5 mph.

1500: 22°C. 65% cloud cover - scattered cirrus & stratus. Westerly wind avg. 5 mph.

# SITE LOG SHEETS

10/02/82

MDT

0830: 3°C. Skies clear, some haze. Calm, cold. All points visible.

0930: 5°C. Skies mostly clear, distant low clouds to NE very light winds from E/SE.

1030: 7°C. Mostly clear, cool. Light easterly winds. All points visible.

1130: 7°C. Mostly clear, cool. Easterly winds 4-8 mph. All points visible.

1300: 10°C. Skies 99% clear. Winds 2-5 mph, southerly. All points visible.

1400: 12°C. Skies 99% clear. Winds 2-5 mph, southerly. All points visible.

1500: 12°C. Skies clear. Winds westerly at 5-8 mph. All points visible.

# SITE LOG SHEETS

10/06/82

MDT

0830: 0°C. Clear, calm. Low lying clouds to the North. Views I & II not visible. Snow on points 5 & 9.

0930: 1°C. Clear, calm - same conditions.

1030: 3°C. 2% cloud cover - low cumulus to the NW 7 N. Low lying clouds to the North. Wind from South avg. 5 mph.

1130: 5°C. 4% cloud cover - low cumulus to the NW, N & NE. Point 1 barely visible. Point 3 has quite a bit of snow accumulation. Southerly wind, avg. 4 mph.

1300: 8°C. 1% cloud cover - low cumulus to the North. Snow mostly melted on Point 3. Snow on top of Point 9. Wind from South avg. 6 mph.

1400: 9°C. A trace of low cumulus to the North. Wind from South, avg. 10 mph. No more snow on Point 3.

1500: 9°C. Clear. Wind from South, avg. 10 mph.

# SITE LOG SHEETS

10/10/82

MDT

0830: -3°C. 40% cloud cover - cirrus & stratus - scattered. Sunny here. Calm. Dusting of snow on all farthest points.

0930: -3°C. 40% cloud cover - mostly to the SE. Some low cumulus at View III. Slight breeze from SE.

1030: -2°C. 40% cloud cover - scattered cirrus, some low cumulus to the NW, N & NE. Slight breeze from SW. Sunny overhead.

1130: 0°C. 50% cloud cover - scattered cirrus, low cumulus to the North & West. A lot of snow on Point 9. Wind from West, avg. 6 mph.

1300: 2°C. 70% cloud cover - cirrus & cumulus. NW wind avg. 6 mph.

1400: 2°C. Same conditions.

1500: 2°C. 30% cloud cover - scattered cumulus. Sunny overhead. Westerly wind, avg. 10 mph.

# SITE LOG SHEETS

10/14/82

MDT

0830: 2°C. 20% cloud cover - stratus & cumulus to the NW, N & NE behind all targets. Sunny here. Calm.

0930: 3°C. Same conditions.

1030: 5°C. Same conditions. Slight breeze from west. Heavy, bright clouds behind View IV.

1130: 8°C. 45% cloud cover. Scattered cumulus & stratus. Cloudy at all targets. Mostly sunny overhead. Slight breeze - 3 mph from North.

1300: 10°C. 50% cloud cover - scattered cumulus & a lot of stratus. Partly sunny overhead. NW wind avg. 5 mph.

1400: 10°C. 20% cloud cover - stratus to the NW, N & NE. A few scattered cumulus. Mostly sunny overhead. Wind from NW avg. 5 mph.

1500: 11°C. 10% cloud cover - stratus on horizon behind all targets. Sunny overhead. Wind from NW avg. 5 mph.

# SITE LOG SHEETS

10/18/82

MDT

0830: 5°C. All points beautiful, visible, mostly clear (98%). Some haze on all horizons. Windy (10-12 mph) from S & SE. Some snow on top of Peak #9.

0930: 9°C. Still 98% clear skies, winds are light from East (1-5 mph). All points visible.

1030: 11°C. Skies 95% clear; light SE winds; all points visible.

1130: 11°C. Skies 90% clear; all points visible; winds 5-10 mph W/SW.

1300: 13°C. Skies 90% clear, all points visible, winds gusty 10-15 mph SE.

1400: 13°C. Gusty winds from S/SW 10-20 mph. Mostly clear skies; all points visible.

1500: 12°C. Winds gusty 10-15 mph from S/SW; skies mostly clear (85-90%). All points visible.

# SITE LOG SHEETS

10/22/82

MDT

0830: 5°C. High overcast, mostly cirrus with about 90% cloudiness (light, thin). Light SE winds (2-4 mph). Haze to N/NW. All points visible. (Coyotes howling to the West).

0930: 7°C. Some stratus to W & to N; mostly overcast (cirrus). Calm; all points visible.

1030: 10°C. High stratus and cirrus to 95% cover (high thin cloudiness). Winds Southeasterly 0-5 mph. All points visible.

1130: 12°C. Almost 100% cloud cover, mostly high cirrus/stratus. Winds southerly light (0-5 mph). All points visible.

1300: 15°C. Winds from East 5-8 mph, 90-95% cloud cover, high cirrus, mostly stratus. All points visible.

1400: 16°C. Winds light from E/SE, 2-6 mph. 98% overcast skies, mixed cumulostratus, stratus, cirrus. All points visible.

1500: 14°C. Calm to light winds form South. 98% cloud cover. All points visible.

# APPENDIX 3-O

## Terrestrial Studies

# APPENDIX 3-1

## Vegetation Data and Analyses

# APPENDIX 3-1.1

## Analyses for Browse Utilization Data

Duncan's Multiple Range Test results for significant main effect differences as identified for analyses summarized on Table 3-3

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=MIXED BRUSH  SPECIES=AMELANCHIER UTAHENSIS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=90  MS=0.009909

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.127705 | 6 | 3 |
| A A | 0.116400 | 15 | 34 |
| A A | 0.095795 | 11 | 2 |
| B A A | 0.050084 | 4 | 33 |
| B A A | 0.046505 | 11 | 1 |
| B A A | 0.041705 | 6 | 4 |
| B A A | 0.036741 | 15 | 35 |
| B A A | 0.011130 | 9 | 32 |
| B | 0.009607 | 22 | 31 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=MIXED BRUSH  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=48  MS=.0407705

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.541858 | 7 | 34 |
| B | 0.101659 | 10 | 1 |
| B | | | |
| B | 0.074509 | 12 | 3 |
| B | | | |
| B | 0.050304 | 9 | 33 |
| B | | | |
| B | 0.033855 | 9 | 4 |
| B | | | |
| B | 0.016674 | 6 | 2 |
| B | | | |
| B | 0.000000 | 2 | 32 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=PINYON JUNIPER  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=142  MS=.0509918

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.588587 | 3 | 12 |
| A | | | |
| B A | 0.381266 | 11 | 5 |
| B A | | | |
| B A | 0.352738 | 17 | 48 |
| B | | | |
| B C | 0.259651 | 10 | 37 |
| B C | | | |
| B C | 0.259394 | 14 | 7 |
| B C | | | |
| B C | 0.257925 | 11 | 19 |
| B C | | | |
| B C | 0.234336 | 11 | 17 |
| C | | | |
| C | 0.129021 | 18 | 43 |
| C | | | |
| C | 0.101874 | 12 | 42 |
| C | | | |
| C | 0.101005 | 5 | 40 |
| C | | | |
| C | 0.097305 | 18 | 36 |
| C | | | |
| C | 0.091052 | 5 | 16 |
| C | | | |
| C | 0.058846 | 20 | 49 |
| C | | | |
| C | 0.000000 | 1 | 46 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=PINYON JUNIPER  SPECIES=CERCOCARPUS MONTANUS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=23  MS=.0617163

| GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| A | | 1.015985 | 1 | 16 |
| A | | | | |
| A | | 0.588343 | 7 | 17 |
| A | | | | |
| A | | 0.542426 | 9 | 12 |
| A | | | | |
| B | A | 0.252680 | 1 | 48 |
| B | | | | |
| B | | 0.148374 | 10 | 6 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=PINYON JUNIPER  SPECIES=JUNIPERUS OSTEOSPERMA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=38  MS=1.8E-04

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.050084 | 2 | 17 |
| B | 0.016674 | 3 | 36 |
| B | | | |
| B | 0.010000 | 1 | 48 |
| B | | | |
| B | 0.000000 | 2 | 5 |
| B | | | |
| B | 0.000000 | 2 | 7 |
| B | | | |
| B | 0.000000 | 5 | 11 |
| B | | | |
| B | 0.000000 | 1 | 12 |
| B | | | |
| B | 0.000000 | 3 | 16 |
| B | | | |
| B | 0.000000 | 4 | 19 |
| B | | | |
| B | 0.000000 | 3 | 37 |
| B | | | |
| B | 0.000000 | 12 | 40 |
| B | | | |
| B | 0.000000 | 5 | 42 |
| B | | | |
| B | 0.000000 | 2 | 43 |
| B | | | |
| B | 0.000000 | 7 | 46 |
| B | | | |
| B | 0.000000 | 1 | 49 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=PINYON JUNIPER  SPECIES=PURSHIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=19  MS=0.075815

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 1.023532 | 2 | 42 |
| A | | | |
| B A | 0.876663 | 3 | 46 |
| B A | | | |
| B A | 0.765110 | 10 | 11 |
| B A | | | |
| B A C | 0.513731 | 2 | 43 |
| B C | | | |
| B C | 0.201358 | 1 | 12 |
| B C | | | |
| B C | 0.201358 | 1 | 16 |
| C | | | |
| C | 0.188918 | 7 | 37 |
| C | | | |
| C | 0.000000 | 1 | 17 |
| C | | | |
| C | 0.000000 | 1 | 19 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR THE CURRENT MONITORING YEAR
VEGETATION TYPE=SAGEBRUSH  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=262  MS=.0337217

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.416521 | 13 | 10 |
| A<br>B A | 0.301280 | 14 | 8 |
| B<br>B | 0.276176 | 19 | 47 |
| B C | 0.217898 | 19 | 20 |
| B C<br>B C | 0.196010 | 21 | 50 |
| B C<br>B C D | 0.176042 | 21 | 44 |
| C D<br>E C D | 0.137170 | 20 | 41 |
| E C D<br>E F C D | 0.093982 | 15 | 15 |
| E F D<br>E F D | 0.065363 | 20 | 38 |
| E F<br>E F | 0.050154 | 22 | 30 |
| E F<br>E F | 0.044804 | 16 | 22 |
| E F<br>E F | 0.042909 | 15 | 14 |
| E F<br>E F | 0.031518 | 21 | 39 |
| E F<br>E F | 0.015647 | 16 | 28 |
| F<br>F | 0.004002 | 25 | 45 |

Duncan's Multiple Range Test results for significant main effect differences as identified for analyses summarized on Table 3-4.

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=MIXED BRUSH  SPECIES=AMELANCHIER UTAHENSIS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=483  MS=.0172656

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.090723 | 116 | 1978 |
| A | | | |
| A | 0.082283 | 108 | 1979 |
| A | | | |
| A | 0.077473 | 100 | 1981 |
| A | | | |
| A | 0.054452 | 99 | 1982 |
| B | | | |
| B | 0.029995 | 105 | 1980 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=MIXED BRUSH  SPECIES=AMELANCHIER UTAHENSIS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=483  MS=.0172656

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.147366 | 82 | 34 |
| A | | | |
| B A | 0.109501 | 33 | 4 |
| B | | | |
| B C | 0.095269 | 58 | 2 |
| B C | | | |
| B C D | 0.079526 | 21 | 33 |
| B C D | | | |
| B C D | 0.058618 | 29 | 3 |
| B C D | | | |
| B C D | 0.057918 | 59 | 1 |
| C D | | | |
| C D | 0.044611 | 56 | 32 |
| D | | | |
| D | 0.037598 | 81 | 35 |
| D | | | |
| D | 0.019670 | 109 | 31 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=MIXED BRUSH  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=239  MS=0.03821

| GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| | A | 0.228366 | 34 | 34 |
| | B | 0.117410 | 45 | 33 |
| | B | | | |
| C | B | 0.059157 | 60 | 3 |
| C | B | | | |
| C | B | 0.051168 | 10 | 32 |
| C | B | | | |
| C | B | 0.040810 | 50 | 1 |
| C | B | | | |
| C | B | 0.020055 | 30 | 2 |
| C | | | | |
| C | | 0.018391 | 45 | 4 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=AMELANCHIER UTAHENSIS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=47  MS=.0099968

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.170451 | 13 | 1979 |
| A | | | |
| B A | 0.102181 | 12 | 1978 |
| B | | | |
| B | 0.072049 | 12 | 1982 |
| B | | | |
| B | 0.054855 | 13 | 1980 |
| B | | | |
| B | 0.031796 | 12 | 1981 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=532  MS=.0505931

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.265570 | 91 | 1978 |
| B | 0.198928 | 156 | 1982 |
| C | 0.124405 | 90 | 1979 |
| C | 0.095124 | 92 | 1980 |
| D | | | |
| D | 0.057890 | 157 | 1981 |
| D | | | |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=532  MS=.0505931

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.364390 | 18 | 12 |
| B | 0.238435 | 52 | 37 |
| B | | | |
| B | 0.219157 | 33 | 48 |
| B | | | |
| B | 0.202861 | 60 | 19 |
| B | | | |
| C B | 0.186515 | 57 | 5 |
| C B | | | |
| C B | 0.163079 | 55 | 17 |
| C D | | | |
| C E D | 0.107711 | 94 | 36 |
| E D | | | |
| E D | 0.099510 | 74 | 7 |
| E D | | | |
| E D | 0.089882 | 36 | 43 |
| E D | | | |
| E D | 0.077902 | 15 | 40 |
| E D | | | |
| E D | 0.070168 | 24 | 42 |
| E D | | | |
| E D | 0.056802 | 25 | 16 |
| E | | | |
| E | 0.031924 | 40 | 49 |
| E | | | |
| E | 0.000000 | 1 | 18 |
| E | | | |
| E | 0.000000 | 2 | 46 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=CERCOCARPUS MONTANUS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=113  MS=0.098748

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.938027 | 25 | 1978 |
| B | 0.612269 | 27 | 1979 |
| C | 0.419737 | 28 | 1982 |
| C | 0.385336 | 28 | 1981 |
| C | 0.384554 | 27 | 1980 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=CERCOCARPUS MONTANUS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=113  MS=0.098748

| GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| | A | 0.788965 | 35 | 17 |
| | A | | | |
| B | A | 0.682993 | 43 | 12 |
| B | A | | | |
| B | A | 0.605998 | 5 | 16 |
| B | | | | |
| B | C | 0.278686 | 2 | 48 |
| | C | | | |
| | C | 0.246742 | 50 | 6 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER SPECIES=PINUS EDULIS

GEVERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=195 MS=.0275891

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.158901 | 47 | 1978 |
| B | 0.084326 | 46 | 1979 |
| B | | | |
| B | 0.053755 | 43 | 1980 |
| B | | | |
| B | 0.030945 | 60 | 1981 |
| B | | | |
| B | 0.015350 | 60 | 1982 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER SPECIES=PINUS EDULIS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=195 MS=.0275891

| GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| | A | 0.446999 | 5 | 17 |
| | A | | | |
| B | A | 0.299441 | 8 | 18 |
| B | | | | |
| B | C | 0.183433 | 27 | 19 |
| | C | | | |
| D | C | 0.102108 | 10 | 6 |
| D | C | | | |
| D | C | 0.100423 | 5 | 36 |
| D | C | | | |
| D | C | 0.067119 | 3 | 43 |
| D | | | | |
| D | | 0.059433 | 40 | 11 |
| D | | | | |
| D | | 0.053399 | 23 | 16 |
| D | | | | |
| D | | 0.023598 | 20 | 37 |
| D | | | | |
| D | | 0.018700 | 30 | 7 |
| D | | | | |
| D | | 0.015512 | 20 | 46 |
| D | | | | |
| D | | 0.012505 | 4 | 48 |
| D | | | | |
| D | | 0.004001 | 30 | 5 |
| D | | | | |
| D | | 0.000909 | 11 | 40 |
| D | | | | |
| D | | 0.000000 | 20 | 12 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=PURSHIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=105  MS=0.100326

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.993019 | 31 | 1978 |
| B | 0.538599 | 28 | 1982 |
| B | | | |
| B | 0.505010 | 28 | 1981 |
| C | 0.385538 | 21 | 1980 |
| C | | | |
| C | 0.263329 | 33 | 1979 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=PURSHIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=105  MS=0.100326

| GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| | A | 1.056899 | 4 | 42 |
| | A | | | |
| B | A | 0.741477 | 50 | 11 |
| B | | | | |
| B | C | 0.561850 | 4 | 43 |
| | C | | | |
| | C | 0.536561 | 24 | 18 |
| | C | | | |
| | C | 0.488565 | 6 | 46 |
| | C | | | |
| | C | 0.417222 | 35 | 37 |
| | C | | | |
| D | C | 0.306703 | 5 | 16 |
| D | C | | | |
| D | C | 0.249361 | 5 | 12 |
| D | | | | |
| D | | 0.012505 | 4 | 17 |
| D | | | | |
| D | | 0.000000 | 4 | 19 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER JSAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=PINYON JUNIPER  SPECIES=SYMPHORICARPOS OREOPHILUS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=16  MS=0.166021

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.982749 | 5 | 1979 |
| B | 0.080339 | 5 | 1982 |
| B | 0.050254 | 6 | 1978 |
| B | 0.040118 | 5 | 1980 |
| B | 0.000000 | 5 | 1981 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=SAGEBRUSH  SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05  DF=1028  MS=.0304952

| GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.302222 | 184 | 1978 |
| B | 0.129133 | 277 | 1982 |
| C | 0.056100 | 275 | 1981 |
| C<br>D | 0.040377 | 179 | 1979 |
| D | 0.011391 | 173 | 1980 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
BROWSE CONDITION AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE
COMPARING ARCSINE TRANSFORMED ESTIMATES OF LEADER USAGE
AMONG YEARS AND TRANSECTS BY VEGETATION TYPE AND SPECIES
FOR ALL YEARS SAMPLED
VEGETATION TYPE=SAGEBRUSH SPECIES=ARTEMISIA TRIDENTATA

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE ASLU
ARCSINE TRANSFORMED LEADER USAGE

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=1028 MS=.0304952

| GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 0.226576 | 72 | 10 |
| A | | | |
| A | 0.214089 | 72 | 8 |
| A | | | |
| B A | 0.177071 | 38 | 47 |
| B | | | |
| B | 0.153171 | 111 | 30 |
| B | | | |
| B | 0.144780 | 100 | 38 |
| B | | | |
| B | 0.128250 | 42 | 50 |
| B | | | |
| B | 0.121917 | 93 | 20 |
| B | | | |
| B | 0.113476 | 85 | 15 |
| B | | | |
| B C | 0.095673 | 42 | 44 |
| B C | | | |
| B C | 0.094714 | 40 | 41 |
| C | | | |
| D C | 0.052898 | 82 | 22 |
| D C | | | |
| D C | 0.044660 | 100 | 39 |
| D C | | | |
| D C | 0.028942 | 79 | 14 |
| D | | | |
| D | 0.008006 | 50 | 45 |
| D | | | |
| D | 0.004883 | 82 | 28 |

# APPENDIX 3-1.2

## Analyses for Phytosociological Data

Duncan's Multiple Range Test results for significant main effect differences as identified for analyses summarized on Table 3-11.

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
PHYTOSOCIOLOGICAL STUDIES

TWO-WAY NESTED ANALYSIS OF VARIANCE
VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=FORB

ANALYSIS OF VARIANCE PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: ASPC
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=562  MSE=1.5E-04
HARMONIC MEAN OF CELL SIZES=193.185

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | AREA |
|---|---|---|---|
| A | 0.0087950 | 226 | 6 |
| A | | | |
| B A | 0.0064018 | 206 | 5 |
| B | | | |
| B | 0.0058131 | 160 | 7 |

# APPENDIX 3-1.3

Range Production and Utilization Data

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 1 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | COMANDRA UMBELLATA | 7.2 | 72.0 | 64.1 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 7.8 | 78.0 | 69.4 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 30.2 | 302.0 | 268.8 |
| 1 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 3.6 | 36.0 | 32.0 |
| 1 | CAGED | FORB | LINUM LEWISII | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 2.8 | 28.0 | 24.9 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.4 | 74.0 | 65.9 |
| 1 | CAGED | GRASS | STIPA COMATA | 10.7 | 107.0 | 95.2 |
| 2 | UNCAGED | FORB | ASTRAGALUS PURSHII | 4.9 | 49.0 | 43.6 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 2 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 17.7 | 177.0 | 157.5 |
| 2 | UNCAGED | FORB | HEDYSARUM BOREALE | 5.8 | 58.0 | 51.6 |
| 2 | UNCAGED | FORB | LINUM LEWISII | 7.0 | 70.0 | 62.3 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 3.9 | 39.0 | 34.7 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.1 | 101.0 | 89.9 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.9 | 29.0 | 25.8 |
| 2 | UNCAGED | GRASS | PHYSARIA FLORIBUNDA | 0.6 | 6.0 | 5.3 |
| 3 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 3 | CAGED | FORB | ASTRAGALUS PURSHII | 0.8 | 8.0 | 7.1 |
| 3 | CAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 3 | CAGED | FORB | ERIGERON EATONII | 1.7 | 17.0 | 15.1 |
| 3 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.4 | 4.0 | 3.6 |
| 3 | CAGED | FORB | HEDYSARUM BOREALE | 3.6 | 36.0 | 32.0 |
| 3 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.8 | 18.0 | 16.0 |
| 3 | CAGED | FORB | LINUM LEWISII | 0.6 | 6.0 | 5.3 |
| 3 | CAGED | FORB | SENECIO MULTILOBATUS | 0.2 | 2.0 | 1.8 |
| 3 | CAGED | FORB | SPHAERALCEA COCCINEA | 4.4 | 44.0 | 39.2 |
| 3 | CAGED | FORB | TOWNSENDIA INCANA | 0.8 | 8.0 | 7.1 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 13.9 | 139.0 | 123.7 |
| 3 | CAGED | GRASS | KOELERIA MACRANTHA | 2.2 | 22.0 | 19.6 |
| 3 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.5 | 65.0 | 57.8 |
| 3 | CAGED | GRASS | POA SPECIES | 1.5 | 15.0 | 13.3 |
| 4 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.8 | 8.0 | 7.1 |
| 4 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.4 | 4.0 | 3.6 |
| 4 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | TOWNSENDIA INCANA | 1.7 | 17.0 | 15.1 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.7 | 87.0 | 77.4 |
| 5 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 0.4 | 4.0 | 3.6 |
| 5 | UNCAGED | FORB | HEDYSARUM BOREALE | 2.9 | 29.0 | 25.8 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.1 | 31.0 | 27.6 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 7.3 | 73.0 | 65.0 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.8 | 58.0 | 51.6 |
| 5 | UNCAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 6 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | FORB | ASTRAGALUS PURSHII | 1.4 | 14.0 | 12.5 |
| 6 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.5 | 5.0 | 4.4 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 6.7 | 67.0 | 59.6 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 1 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 6 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 7.3 | 73.0 | 65.0 |
| 6 | UNCAGED | FORB | LINUM LEWISII | 1.3 | 13.0 | 11.6 |
| 6 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.7 | 17.0 | 15.1 |
| 6 | UNCAGED | FORB | TOWNSENDIA INCANA | 9.6 | 96.0 | 85.4 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.1 | 21.0 | 18.7 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.8 | 18.0 | 16.0 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.8 | 38.0 | 33.8 |
| 6 | UNCAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 7 | CAGED | FORB | COMANDRA UMBELLATA | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 1.7 | 17.0 | 15.1 |
| 7 | CAGED | FORB | ERIOGONUM UMBELLATUM | 3.0 | 30.0 | 26.7 |
| 7 | CAGED | FORB | HEDYSARUM BOREALE | 15.1 | 151.0 | 134.4 |
| 7 | CAGED | FORB | IPOMOPSIS AGGREGATA | 5.4 | 54.0 | 48.1 |
| 7 | CAGED | FORB | TOWNSENDIA INCANA | 0.6 | 6.0 | 5.3 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 10.2 | 102.0 | 90.8 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.2 | 82.0 | 73.0 |
| 8 | CAGED | FORB | ASTRAGALUS PURSHII | 2.7 | 27.0 | 24.0 |
| 8 | CAGED | FORB | COMANDRA UMBELLATA | 0.2 | 2.0 | 1.8 |
| 8 | CAGED | FORB | CRYPTANTHA SERICEA | 2.2 | 22.0 | 19.6 |
| 8 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.7 | 7.0 | 6.2 |
| 8 | CAGED | FORB | LINUM LEWISII | 0.7 | 7.0 | 6.2 |
| 8 | CAGED | FORB | PHYSARIA FLORIBUNDA | 3.0 | 30.0 | 26.7 |
| 8 | CAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 10.3 | 103.0 | 91.7 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | ASTRAGALUS PURSHII | 1.6 | 16.0 | 14.2 |
| 9 | UNCAGED | FORB | COMANDRA UMBELLATA | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | FORB | LINUM LEWISII | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.9 | 9.0 | 8.0 |
| 9 | UNCAGED | FORB | TOWNSENDIA INCANA | 13.0 | 130.0 | 115.7 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.9 | 59.0 | 52.5 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.8 | 28.0 | 24.9 |
| 10 | CAGED | FORB | ASTRAGALUS PURSHII | 3.8 | 38.0 | 33.8 |
| 10 | CAGED | FORB | COMANDRA UMBELLATA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | HAPLOPAPPUS ACAULIS | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | HEDYSARUM BOREALE | 16.5 | 165.0 | 146.8 |
| 10 | CAGED | FORB | LINUM LEWISII | 12.9 | 129.0 | 114.8 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | TOWNSENDIA INCANA | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 19.4 | 194.0 | 172.7 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 5.8 | 58.0 | 51.6 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.6 | 66.0 | 58.7 |
| 10 | CAGED | GRASS | POA SPECIES | 2.7 | 27.0 | 24.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 1 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|
| TRANSECT SUMMARIES | | GRAMS/M2 | KILOGRAMS/HECTARE | | POUNDS/ACRE |
| CAGED PLOTS | | | | | |
| | FORBS | 136.6 | 1366 | | 1216 |
| | GRASSES | 108.3 | 1083 | | 963.9 |
| TOTAL CAGED | | 244.9 | 2449 | | 2180 |
| UNCAGED PLOTS | | | | | |
| | FORBS | 98.6 | 986.0 | | 877.5 |
| | GRASSES | 56.8 | 568.0 | | 505.5 |
| TOTAL UNCAGED | | 155.4 | 1554 | | 1383 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 2 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | PHYSARIA FLORIBUNDA | 2.9 | 29.0 | 25.8 |
| 2 | CAGED | FORB | COMANDRA UMBELLATA | 0.7 | 7.0 | 6.2 |
| 2 | CAGED | FORB | ERIGERON EATONII | 1.7 | 17.0 | 15.1 |
| 2 | CAGED | FORB | ERIOGONUM UMBELLATUM | 8.3 | 83.0 | 73.9 |
| 2 | CAGED | FORB | PHYSARIA FLORIBUNDA | 1.8 | 18.0 | 16.0 |
| 2 | CAGED | FORB | TOWNSENDIA INCANA | 2.2 | 22.0 | 19.6 |
| 2 | CAGED | FORB | UNKNOWN FORB | 0.4 | 4.0 | 3.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 9.7 | 97.0 | 86.3 |
| 2 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | ASTRAGALUS PURSHII | 2.3 | 23.0 | 20.5 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 2.1 | 21.0 | 18.7 |
| 3 | UNCAGED | FORB | HEDYSARUM BOREALE | 9.3 | 93.0 | 82.8 |
| 3 | UNCAGED | FORB | LINUM LEWISII | 0.9 | 9.0 | 8.0 |
| 3 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.6 | 6.0 | 5.3 |
| 3 | UNCAGED | FORB | TOWNSENDIA INCANA | 2.0 | 20.0 | 17.8 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 19.1 | 191.0 | 170.0 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.7 | 17.0 | 15.1 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.6 | 56.0 | 49.8 |
| 3 | UNCAGED | GRASS | POA SPECIES | 2.9 | 29.0 | 25.8 |
| 4 | CAGED | FORB | ASTRAGALUS PURSHII | 2.7 | 27.0 | 24.0 |
| 4 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | CRYPTANTHA SERICEA | 1.9 | 19.0 | 16.9 |
| 4 | CAGED | FORB | ERIGERON EATONII | 0.7 | 7.0 | 6.2 |
| 4 | CAGED | FORB | LINUM LEWISII | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | FORB | PHYSARIA FLORIBUNDA | 2.3 | 23.0 | 20.5 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 5.6 | 56.0 | 49.8 |
| 4 | CAGED | FORB | UNKNOWN FORB | 13.6 | 136.0 | 121.0 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 6.1 | 61.0 | 54.3 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 4.9 | 49.0 | 43.6 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 10.1 | 101.0 | 89.9 |
| 4 | CAGED | GRASS | POA SPECIES | 6.9 | 69.0 | 61.4 |
| 5 | UNCAGED | | NO VEGETATION | . | . | . |
| 6 | UNCAGED | FORB | ASTRAGALUS PURSHII | 2.3 | 23.0 | 20.5 |
| 6 | UNCAGED | FORB | ERIGERON EATONII | 3.3 | 33.0 | 29.4 |
| 6 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 10.8 | 108.0 | 96.1 |
| 6 | UNCAGED | FORB | LINUM LEWISII | 0.8 | 8.0 | 7.1 |
| 6 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.0 | 80.0 | 71.2 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.4 | 4.0 | 3.6 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |
| 6 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 7 | CAGED | FORB | COMANDRA UMBELLATA | 7.3 | 73.0 | 65.0 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 1.6 | 16.0 | 14.2 |
| 7 | CAGED | FORB | PHYSARIA FLORIBUNDA | 2.8 | 28.0 | 24.9 |
| 7 | CAGED | FORB | TOWNSENDIA INCANA | 0.7 | 7.0 | 6.2 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 12.7 | 127.0 | 113.0 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.2 | 62.0 | 55.2 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 2 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 3.8 | 38.0 | 33.8 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.8 | 8.0 | 7.1 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.4 | 74.0 | 65.9 |
| 9 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | FORB | ERIGERON EATONII | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 8.3 | 83.0 | 73.9 |
| 9 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | UNKNOWN FORB | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.5 | 85.0 | 75.6 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 8.8 | 88.0 | 78.3 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | ASTRAGALUS PURSHII | 2.8 | 28.0 | 24.9 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | LINUM LEWISII | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | FORB | TOWNSENDIA INCANA | 1.0 | 10.0 | 8.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 15.7 | 157.0 | 139.7 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 12.5 | 125.0 | 111.2 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.0 | 20.0 | 17.8 |
| 10 | CAGED | GRASS | POA SPECIES | 2.2 | 22.0 | 19.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 63.9 | 639.0 | 568.7 |
| GRASSES | 89.1 | 891.0 | 793.0 |
| TOTAL CAGED | 153.0 | 1530 | 1362 |
| UNCAGED PLOTS | | | |
| FORBS | 50.1 | 501.0 | 445.9 |
| GRASSES | 66.5 | 665.0 | 591.8 |
| TOTAL UNCAGED | 272.0 | 2720 | 2421 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 3 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | COMANDRA UMBELLATA | 24.9 | 249.0 | 221.6 |
| 1 | CAGED | FORB | CREPIS OCCIDENTALIS | 1.7 | 17.0 | 15.1 |
| 1 | CAGED | FORB | ERIGERON EATONII | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 4.6 | 46.0 | 40.9 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 9.4 | 94.0 | 83.7 |
| 1 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.9 | 19.0 | 16.9 |
| 1 | CAGED | FORB | LINUM LEWISII | 1.1 | 11.0 | 9.8 |
| 1 | CAGED | FORB | PENSTEMON CAESPITOSUS | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 2.7 | 27.0 | 24.0 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 19.3 | 193.0 | 171.8 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | GRASS | POA SPECIES | 6.7 | 67.0 | 59.6 |
| 1 | CAGED | GRASS | STIPA COMATA | 4.4 | 44.0 | 39.2 |
| 2 | CAGED | FORB | COMANDRA UMBELLATA | 9.7 | 97.0 | 86.3 |
| 2 | CAGED | FORB | CREPIS OCCIDENTALIS | 3.9 | 39.0 | 34.7 |
| 2 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | FORB | ERIOGONUM UMBELLATUM | 2.2 | 22.0 | 19.6 |
| 2 | CAGED | FORB | HEDYSARUM BOREALE | 30.1 | 301.0 | 267.9 |
| 2 | CAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | FORB | PENSTEMON CAESPITOSUS | 3.4 | 34.0 | 30.3 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 2.2 | 22.0 | 19.6 |
| 2 | CAGED | GRASS | KOELERIA MACRANTHA | 12.4 | 124.0 | 110.4 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.1 | 11.0 | 9.8 |
| 2 | CAGED | GRASS | POA SPECIES | 5.4 | 54.0 | 48.1 |
| 2 | CAGED | GRASS | STIPA COMATA | 7.0 | 70.0 | 62.3 |
| 3 | UNCAGED | FORB | COMANDRA UMBELLATA | 3.8 | 38.0 | 33.8 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.7 | 7.0 | 6.2 |
| 3 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 8.5 | 85.0 | 75.6 |
| 3 | UNCAGED | FORB | HEDYSARUM BOREALE | 17.7 | 177.0 | 157.5 |
| 3 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 1.7 | 17.0 | 15.1 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.4 | 14.0 | 12.5 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.0 | 20.0 | 17.8 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.3 | 83.0 | 73.9 |
| 4 | UNCAGED | FORB | COMANDRA UMBELLATA | 5.4 | 54.0 | 48.1 |
| 4 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.8 | 8.0 | 7.1 |
| 4 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 2.9 | 29.0 | 25.8 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.3 | 13.0 | 11.6 |
| 4 | UNCAGED | GRASS | POA SPECIES | 0.6 | 6.0 | 5.3 |
| 4 | UNCAGED | GRASS | STIPA COMATA | 10.4 | 104.0 | 92.6 |
| 5 | CAGED | FORB | COMANDRA UMBELLATA | 19.7 | 197.0 | 175.3 |
| 5 | CAGED | FORB | CRUCIFERAE SPECIES | 1.8 | 18.0 | 16.0 |
| 5 | CAGED | FORB | ERIGERON EATONII | 0.2 | 2.0 | 1.8 |
| 5 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.8 | 8.0 | 7.1 |
| 5 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.3 | 13.0 | 11.6 |
| 5 | CAGED | FORB | PENSTEMON CAESPITOSUS | 1.6 | 16.0 | 14.2 |
| 5 | CAGED | FORB | PENSTEMON SPECIES | 1.2 | 12.0 | 10.7 |
| 5 | CAGED | GRASS | AGROPYRON SPECIES | 5.1 | 51.0 | 45.4 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 3 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 5 | CAGED | GRASS | KOELERIA MACRANTHA | 9.2 | 92.0 | 81.9 |
| 5 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.5 | 5.0 | 4.4 |
| 5 | CAGED | GRASS | POA SPECIES | 8.0 | 80.0 | 71.2 |
| 6 | CAGED | FORB | ACHILLEA LANULOSA | 0.3 | 3.0 | 2.7 |
| 6 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | COMANDRA UMBELLATA | 11.7 | 117.0 | 104.1 |
| 6 | CAGED | FORB | ERIOGONUM UMBELLATUM | 3.4 | 34.0 | 30.3 |
| 6 | CAGED | FORB | LITHOSPERMUM SPECIES | 6.4 | 64.0 | 57.0 |
| 6 | CAGED | FORB | LUPINUS ARGENTEUS | 9.1 | 91.0 | 81.0 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | CAREX SPECIES | 2.4 | 24.0 | 21.4 |
| 6 | CAGED | GRASS | POA SPECIES | 12.5 | 125.0 | 111.2 |
| 7 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 0.8 | 8.0 | 7.1 |
| 7 | UNCAGED | FORB | COMANDRA UMBELLATA | 10.4 | 104.0 | 92.6 |
| 7 | UNCAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 7 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 3.8 | 38.0 | 33.8 |
| 7 | UNCAGED | FORB | LUPINUS ARGENTEUS | 5.8 | 58.0 | 51.6 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.0 | 20.0 | 17.8 |
| 7 | UNCAGED | GRASS | POA SPECIES | 26.8 | 268.0 | 238.5 |
| 8 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 5.1 | 51.0 | 45.4 |
| 8 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 0.8 | 8.0 | 7.1 |
| 8 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 1.8 | 18.0 | 16.0 |
| 8 | UNCAGED | FORB | LUPINUS ARGENTEUS | 16.0 | 160.0 | 142.4 |
| 8 | UNCAGED. | FORB | PENSTEMON CAESPITOSUS | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | FORB | PENSTEMON SPECIES | 4.0 | 40.0 | 35.6 |
| 8 | UNCAGED | GRASS | CAREX SPECIES | 4.9 | 49.0 | 43.6 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.0 | 20.0 | 17.8 |
| 8 | UNCAGED | GRASS | POA SPECIES | 9.8 | 98.0 | 87.2 |
| 9 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 1.7 | 17.0 | 15.1 |
| 9 | UNCAGED | FORB | COMANDRA UMBELLATA | 20.1 | 201.0 | 178.9 |
| 9 | UNCAGED | FORB | LINUM LEWISII | 2.9 | 29.0 | 25.8 |
| 9 | UNCAGED | FORB | UNKNOWN FORB | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.9 | 89.0 | 79.2 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.1 | 11.0 | 9.8 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.3 | 33.0 | 29.4 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 2.3 | 23.0 | 20.5 |
| 10 | CAGED | FORB | COMANDRA UMBELLATA | 5.7 | 57.0 | 50.7 |
| 10 | CAGED | FORB | ERIGERON EATONII | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | HEDYSARUM BOREALE | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | LUPINUS ARGENTEUS | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | PENSTEMON CAESPITOSUS | 2.5 | 25.0 | 22.2 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.6 | 6.0 | 5.3 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 6.8 | 68.0 | 60.5 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 5.6 | 56.0 | 49.8 |
| 10 | CAGED | GRASS | POA SPECIES | 10.2 | 102.0 | 90.8 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 3 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|
| TRANSECT SUMMARIES | | GRAMS/M2 | KILOGRAMS/HECTARE | | POUNDS/ACRE |
| CAGED PLOTS | | | | | |
| | FORBS | | 166.5 | 1665 | 1482 |
| | GRASSES | | 122.5 | 1225 | 1090 |
| TOTAL CAGED | | | 289.0 | 2890 | 2572 |
| UNCAGED PLOTS | | | | | |
| | FORBS | | 116.8 | 1168 | 1040 |
| | GRASSES | | 82.9 | 829.0 | 737.8 |
| TOTAL UNCAGED | | | 471.7 | 4717 | 4198 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 4 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 4.8 | 48.0 | 42.7 |
| 1 | CAGED | FORB | CREPIS OCCIDENTALIS | 5.3 | 53.0 | 47.2 |
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 2.3 | 23.0 | 20.5 |
| 1 | CAGED | FORB | ERIGERON EATONII | 4.0 | 40.0 | 35.6 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 8.5 | 85.0 | 75.6 |
| 1 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | FORB | LUPINUS ARGENTEUS | 4.9 | 49.0 | 43.6 |
| 1 | CAGED | FORB | PENSTEMON CAESPITOSUS | 4.7 | 47.0 | 41.8 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 1.7 | 17.0 | 15.1 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 11.4 | 114.0 | 101.5 |
| 1 | CAGED | GRASS | POA SPECIES | 4.0 | 40.0 | 35.6 |
| 2 | UNCAGED | FORB | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | COMANDRA UMBELLATA | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 4.5 | 45.0 | 40.0 |
| 2 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 3.2 | 32.0 | 28.5 |
| 2 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 3 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | BALSAMORHIZA SAGITTATA | 6.4 | 64.0 | 57.0 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 8.2 | 82.0 | 73.0 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.1 | 21.0 | 18.7 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | POA SPECIES | 8.2 | 82.0 | 73.0 |
| 4 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.2 | 2.0 | 1.8 |
| 4 | UNCAGED | FORB | ERIGERON EATONII | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 4.6 | 46.0 | 40.9 |
| 4 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 5.3 | 53.0 | 47.2 |
| 4 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.3 | 3.0 | 2.7 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.2 | 132.0 | 117.5 |
| 4 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.8 | 28.0 | 24.9 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | FORB | ASTRAGALUS PURSHII | 1.3 | 13.0 | 11.6 |
| 5 | UNCAGED | FORB | BALSAMORHIZA SAGITTATA | 13.3 | 133.0 | 118.4 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.6 | 6.0 | 5.3 |
| 5 | UNCAGED | FORB | ERIGERON EATONII | 1.4 | 14.0 | 12.5 |
| 5 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | FORB | LUPINUS ARGENTEUS | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 1.3 | 13.0 | 11.6 |
| 5 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.3 | 83.0 | 73.9 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.8 | 28.0 | 24.9 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 4 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 5 | UNCAGED | GRASS | POA SPECIES | 4.2 | 42.0 | 37.4 |
| 6 | CAGED | FORB | CHAENACTIS DOUGLASII | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | ERIGERON EATONII | 1.9 | 19.0 | 16.9 |
| 6 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.3 | 3.0 | 2.7 |
| 6 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 11.9 | 119.0 | 105.9 |
| 6 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.4 | 4.0 | 3.6 |
| 6 | CAGED | FORB | PENSTEMON CAESPITOSUS | 6.3 | 63.0 | 56.1 |
| 6 | CAGED | FORB | PHYSARIA FLORIBUNDA | 2.1 | 21.0 | 18.7 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 3.9 | 39.0 | 34.7 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 2.6 | 26.0 | 23.1 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 7 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | ERIOGONUM UMBELLATUM | 4.6 | 46.0 | 40.9 |
| 7 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.3 | 3.0 | 2.7 |
| 7 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | GRASS | BROMUS TECTORUM | 1.0 | 10.0 | 8.9 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 4.2 | 42.0 | 37.4 |
| 7 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | GRASS | SITANION HYSTRIX | 3.7 | 37.0 | 32.9 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 8 | UNCAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 8.2 | 82.0 | 73.0 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 4.8 | 48.0 | 42.7 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.9 | 89.0 | 79.2 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 0.3 | 3.0 | 2.7 |
| 9 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 10.1 | 101.0 | 89.9 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 4.7 | 47.0 | 41.8 |
| 9 | CAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 0.4 | 4.0 | 3.6 |
| 9 | CAGED | FORB | PENSTEMON CAESPITOSUS | 14.2 | 142.0 | 126.4 |
| 9 | CAGED | FORB | SPHAERALCEA COCCINEA | 3.7 | 37.0 | 32.9 |
| 9 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 3.9 | 39.0 | 34.7 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 19.2 | 192.0 | 170.9 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 15.3 | 153.0 | 136.2 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 29.6 | 296.0 | 263.4 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 97.1 | 971.0 | 864.2 |
| GRASSES | 101.3 | 1013 | 901.6 |
| TOTAL CAGED | 198.4 | 1984 | 1766 |
| UNCAGED PLOTS | | | |
| FORBS | 70.8 | 708.0 | 630.1 |
| GRASSES | 53.8 | 538.0 | 478.8 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 4 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| TOTAL | UNCAGED | | 596.3 | 5963 | 5307 | |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 5 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | POA SPECIES | 9.3 | 93.0 | 82.8 |
| 1 | CAGED | GRASS | SITANION HYSTRIX | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 1.3 | 13.0 | 11.6 |
| 3 | CAGED | GRASS | POA SPECIES | 3.3 | 33.0 | 29.4 |
| 4 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | GRASS | POA SPECIES | 2.3 | 23.0 | 20.5 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 5.7 | 57.0 | 50.7 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | POA SPECIES | 3.8 | 38.0 | 33.8 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 6.5 | 65.0 | 57.8 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 3.6 | 36.0 | 32.0 |
| 6 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | GRASS | POA SPECIES | 7.4 | 74.0 | 65.9 |
| 6 | UNCAGED | GRASS | SITANION HYSTRIX | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 1.7 | 17.0 | 15.1 |
| 7 | CAGED | GRASS | POA SPECIES | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.9 | 9.0 | 8.0 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 5.1 | 51.0 | 45.4 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 1.7 | 17.0 | 15.1 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | TARAXACUM OFFICINALE | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 8 | UNCAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 9 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 4.1 | 41.0 | 36.5 |
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | GRASS | POA SPECIES | 1.5 | 15.0 | 13.3 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 3.0 | 30.0 | 26.7 |
| 10 | CAGED | FORB | ASTRAGALUS PURSHII | 3.4 | 34.0 | 30.3 |
| 10 | CAGED | FORB | PHLOX HOODII | 3.9 | 39.0 | 34.7 |
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 9.1 | 91.0 | 81.0 |
| GRASSES | 15.5 | 155.0 | 137.9 |
| TOTAL CAGED | 24.6 | 246.0 | 218.9 |
| UNCAGED PLOTS | | | |
| FORBS | 31.1 | 311.0 | 276.8 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 5 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|
| GRASSES | | 23.2 | 232.0 | 206.5 | |
| TOTAL UNCAGED | | 650.6 | 6506 | 5790 | |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 6 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 0.6 | 6.0 | 5.3 |
| 1 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 3.3 | 33.0 | 29.4 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.1 | 21.0 | 18.7 |
| 2 | UNCAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 3 | CAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 2.3 | 23.0 | 20.5 |
| 3 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.8 | 8.0 | 7.1 |
| 4 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 7.8 | 78.0 | 69.4 |
| 4 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 5 | CAGED | | NO VEGETATION | . | . | . |
| 6 | UNCAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 1.5 | 15.0 | 13.3 |
| 6 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 4.1 | 41.0 | 36.5 |
| 7 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.7 | 17.0 | 15.1 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 12.5 | 125.0 | 111.2 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 7.5 | 75.0 | 66.7 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 19.1 | 191.0 | 170.0 |
| GRASSES | 1.1 | 11.0 | 9.8 |
| TOTAL CAGED | 20.2 | 202.0 | 179.8 |
| UNCAGED PLOTS | | | |
| FORBS | 23.9 | 239.0 | 212.7 |
| GRASSES | 3.2 | 32.0 | 28.5 |
| TOTAL UNCAGED | 677.7 | 6777 | 6032 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 7 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 11.3 | 113.0 | 100.6 |
| 1 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | STIPA COMATA | 6.4 | 64.0 | 57.0 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 7.5 | 75.0 | 66.7 |
| 2 | CAGED | GRASS | BROMUS TECTORUM | 8.5 | 85.0 | 75.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 30.0 | 300.0 | 267.0 |
| 2 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.7 | 107.0 | 95.2 |
| 3 | UNCAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.5 | 5.0 | 4.4 |
| 4 | CAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 5 | CAGED | | NO VEGETATION | . | . | . |
| 6 | UNCAGED | | NO VEGETATION | . | . | . |
| 7 | UNCAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | GRASS | SITANION HYSTRIX | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | | NO VEGETATION | . | . | . |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.5 | 85.0 | 75.6 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | POA SPECIES | 1.1 | 11.0 | 9.8 |
| 10 | CAGED | GRASS | STIPA COMATA | 0.1 | 1.0 | 0.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 0.1 | 1.0 | 0.9 |
| GRASSES | 65.3 | 653.0 | 581.2 |
| TOTAL CAGED | 65.4 | 654.0 | 582.1 |
| UNCAGED PLOTS | | | |
| FORBS | 0.1 | 1.0 | 0.9 |
| GRASSES | 19.9 | 199.0 | 177.1 |
| TOTAL UNCAGED | 697.7 | 6977 | 6210 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 8 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CHAENACTIS DOUGLASII | 1.7 | 17.0 | 15.1 |
| 1 | CAGED | FORB | ERIGERON EATONII | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | FORB | PHLOX HOODII | 2.7 | 27.0 | 24.0 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 1.9 | 19.0 | 16.9 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 1.0 | 10.0 | 8.9 |
| 1 | CAGED | FORB | UNKNOWN FORB | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 0.6 | 6.0 | 5.3 |
| 1 | CAGED | GRASS | CAREX SPECIES | 3.0 | 30.0 | 26.7 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | POA SPECIES | 14.3 | 143.0 | 127.3 |
| 1 | CAGED | GRASS | STIPA COMATA | 1.9 | 19.0 | 16.9 |
| 2 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 2.3 | 23.0 | 20.5 |
| 2 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | FORB | SENECIO MULTILOBATUS | 1.4 | 14.0 | 12.5 |
| 2 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.1 | 11.0 | 9.8 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 2.4 | 24.0 | 21.4 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.0 | 20.0 | 17.8 |
| 2 | UNCAGED | GRASS | POA SPECIES | 4.4 | 44.0 | 39.2 |
| 3 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 1.8 | 18.0 | 16.0 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 3.3 | 33.0 | 29.4 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 7.2 | 72.0 | 64.1 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.5 | 5.0 | 4.4 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.9 | 9.0 | 8.0 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 2.2 | 22.0 | 19.6 |
| 4 | CAGED | FORB | CRYPTANTHA SERICEA | 1.2 | 12.0 | 10.7 |
| 4 | CAGED | FORB | ERIGERON EATONII | 0.5 | 5.0 | 4.4 |
| 4 | CAGED | FORB | PHLOX HOODII | 1.9 | 19.0 | 16.9 |
| 4 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | GRASS | CAREX SPECIES | 4.0 | 40.0 | 35.6 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 9.6 | 96.0 | 85.4 |
| 4 | CAGED | GRASS | POA SPECIES | 2.9 | 29.0 | 25.8 |
| 4 | CAGED | GRASS | STIPA COMATA | 13.5 | 135.0 | 120.1 |
| 5 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | FORB | ERIGERON EATONII | 1.3 | 13.0 | 11.6 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 18.5 | 185.0 | 164.6 |
| 5 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 2.2 | 22.0 | 19.6 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 2.3 | 23.0 | 20.5 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.8 | 18.0 | 16.0 |
| 5 | UNCAGED | GRASS | POA SPECIES | 2.1 | 21.0 | 18.7 |
| 6 | CAGED | FORB | SENECIO MULTILOBATUS | 3.6 | 36.0 | 32.0 |
| 6 | CAGED | FORB | SPHAERALCEA COCCINEA | 2.8 | 28.0 | 24.9 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 6 | CAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 1.3 | 13.0 | 11.6 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 8 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 6 | CAGED | GRASS | POA SPECIES | 6.0 | 60.0 | 53.4 |
| 7 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 0.2 | 2.0 | 1.8 |
| 7 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | ERIOGONUM LONCHOPHYLLUM | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.4 | 4.0 | 3.6 |
| 7 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.6 | 6.0 | 5.3 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.3 | 33.0 | 29.4 |
| 7 | UNCAGED | GRASS | POA SPECIES | 7.4 | 74.0 | 65.9 |
| 8 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 0.3 | 3.0 | 2.7 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.8 | 8.0 | 7.1 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 14.6 | 146.0 | 129.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | GRASS | POA SPECIES | 11.2 | 112.0 | 99.7 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 1.1 | 11.0 | 9.8 |
| 9 | CAGED | FORB | CREPIS OCCIDENTALIS | 1.2 | 12.0 | 10.7 |
| 9 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | SENECIO MULTILOBATUS | 1.1 | 11.0 | 9.8 |
| 9 | CAGED | FORB | SPHAERALCEA COCCINEA | 4.4 | 44.0 | 39.2 |
| 9 | CAGED | FORB | TOWNSENDIA INCANA | 4.6 | 46.0 | 40.9 |
| 9 | CAGED | GRASS | KOELERIA MACRANTHA | 1.2 | 12.0 | 10.7 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | GRASS | POA SPECIES | 4.4 | 44.0 | 39.2 |
| 9 | CAGED | GRASS | STIPA COMATA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | CREPIS OCCIDENTALIS | 4.6 | 46.0 | 40.9 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | ERIGERON EATONII | 3.5 | 35.0 | 31.1 |
| 10 | CAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 1.9 | 19.0 | 16.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 6.2 | 62.0 | 55.2 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 2.2 | 22.0 | 19.6 |
| 10 | CAGED | GRASS | POA SPECIES | 7.3 | 73.0 | 65.0 |
| 10 | CAGED | GRASS | STIPA COMATA | 2.2 | 22.0 | 19.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 41.4 | 414.0 | 368.5 |
| GRASSES | 83.8 | 838.0 | 745.8 |
| TOTAL CAGED | 125.2 | 1252 | 1114 |
| UNCAGED PLOTS | | | |
| FORBS | 50.3 | 503.0 | 447.7 |
| GRASSES | 56.9 | 569.0 | 506.4 |
| TOTAL UNCAGED | 804.9 | 8049 | 7164 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 10 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 18.1 | 181.0 | 161.1 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 20.9 | 209.0 | 186.0 |
| 1 | CAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | FORB | PHLOX HOODII | 6.2 | 62.0 | 55.2 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 27.2 | 272.0 | 242.1 |
| 2 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 27.4 | 274.0 | 243.9 |
| 3 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.8 | 78.0 | 69.4 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 4 | UNCAGED | FORB | ERIGERON EATONII | 1.1 | 11.0 | 9.8 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 20.6 | 206.0 | 183.3 |
| 4 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 18.4 | 184.0 | 163.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 12.6 | 126.0 | 112.1 |
| 5 | UNCAGED | GRASS | SITANION HYSTRIX | 9.5 | 95.0 | 84.5 |
| 6 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 1.8 | 18.0 | 16.0 |
| 6 | UNCAGED | FORB | PENSTEMON CAESPITOSUS | 2.9 | 29.0 | 25.8 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 19.8 | 198.0 | 176.2 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.9 | 79.0 | 70.3 |
| 6 | UNCAGED | GRASS | POA SPECIES | 0.9 | 9.0 | 8.0 |
| 7 | CAGED | FORB | PHLOX HOODII | 9.4 | 94.0 | 83.7 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 9.6 | 96.0 | 85.4 |
| 7 | CAGED | GRASS | POA SPECIES | 1.2 | 12.0 | 10.7 |
| 8 | CAGED | FORB | PHLOX HOODII | 32.0 | 320.0 | 284.8 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 8.4 | 84.0 | 74.8 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.0 | 70.0 | 62.3 |
| 8 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.9 | 9.0 | 8.0 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 21.7 | 217.0 | 193.1 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.4 | 134.0 | 119.3 |
| 9 | UNCAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | PHLOX HOODII | 15.0 | 150.0 | 133.5 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 17.2 | 172.0 | 153.1 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 14.0 | 140.0 | 124.6 |
| 10 | CAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 81.0 | 810.0 | 720.9 |
| GRASSES | 106.2 | 1062 | 945.2 |
| TOTAL CAGED | 187.2 | 1872 | 1666 |

APPENDIX

RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 10 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| UNCAGED PLOTS | | | | | | |
| FORBS | | 98.0 | 980.0 | | 872.2 | |
| GRASSES | | 72.3 | 723.0 | | 643.5 | |
| TOTAL UNCAGED | | 975.2 | 9752 | | 8679 | |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 11 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | POA SPECIES | 3.1 | 31.0 | 27.6 |
| 2 | UNCAGED | | NO VEGETATION | • | • | • |
| 3 | UNCAGED | FORB | LEPTODACTYLON PUNGENS | 3.1 | 31.0 | 27.6 |
| 3 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 3.7 | 37.0 | 32.9 |
| 3 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.4 | 4.0 | 3.6 |
| 3 | UNCAGED | FORB | TOWNSENDIA INCANA | 1.9 | 19.0 | 16.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.0 | 70.0 | 62.3 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 1.6 | 16.0 | 14.2 |
| 4 | CAGED | FORB | ASTRAGALUS SPATULATUS | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | CRUCIFERAE SPECIES | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.4 | 14.0 | 12.5 |
| 4 | CAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 1.5 | 15.0 | 13.3 |
| 6 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | TOWNSENDIA INCANA | 0.6 | 6.0 | 5.3 |
| 7 | UNCAGED | | NO VEGETATION | • | • | • |
| 8 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.8 | 18.0 | 16.0 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.4 | 4.0 | 3.6 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 3.1 | 31.0 | 27.6 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 0.4 | 4.0 | 3.6 |
| 9 | CAGED | FORB | LEPTODACTYLON PUNGENS | 4.1 | 41.0 | 36.5 |
| 9 | CAGED | FORB | TOWNSENDIA INCANA | 4.0 | 40.0 | 35.6 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 1.8 | 18.0 | 16.0 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 12.4 | 124.0 | 110.4 |
| GRASSES | 4.8 | 48.0 | 42.7 |
| TOTAL CAGED | 17.2 | 172.0 | 153.1 |
| UNCAGED PLOTS | | | |
| FORBS | 15.9 | 159.0 | 141.5 |
| GRASSES | 9.4 | 94.0 | 83.7 |
| TOTAL UNCAGED | 1000 | 10005 | 8904 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 12 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | | NO VEGETATION | • | • | • |
| 2 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 4.1 | 41.0 | 36.5 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 0.8 | 8.0 | 7.1 |
| 3 | UNCAGED | GRASS | POA SPECIES | 4.2 | 42.0 | 37.4 |
| 4 | CAGED | FORB | CRUCIFERAE SPECIES | 3.6 | 36.0 | 32.0 |
| 4 | CAGED | FORB | CRYPTANTHA SERICEA | 0.6 | 6.0 | 5.3 |
| 4 | CAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | SENECIO MULTILOBATUS | 0.6 | 6.0 | 5.3 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 2.5 | 25.0 | 22.2 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 2.0 | 20.0 | 17.8 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.6 | 6.0 | 5.3 |
| 6 | CAGED | FORB | CRUCIFERAE SPECIES | 0.6 | 6.0 | 5.3 |
| 6 | CAGED | FORB | PHLOX HOODII | 5.6 | 56.0 | 49.8 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 0.6 | 6.0 | 5.3 |
| 6 | CAGED | GRASS | POA SPECIES | 8.4 | 84.0 | 74.8 |
| 7 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | PHLOX HOODII | 7.6 | 76.0 | 67.6 |
| 7 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 7 | CAGED | GRASS | POA SPECIES | 4.6 | 46.0 | 40.9 |
| 8 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.9 | 59.0 | 52.5 |
| 8 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 8.5 | 85.0 | 75.6 |
| 9 | UNCAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | SENECIO MULTILOBATUS | 2.1 | 21.0 | 18.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | GRASS | CAREX SPECIES | 14.4 | 144.0 | 128.2 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | STIPA COMATA | 0.7 | 7.0 | 6.2 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 21.1 | 211.0 | 187.8 |
| GRASSES | 31.2 | 312.0 | 277.7 |
| TOTAL CAGED | 52.3 | 523.0 | 465.5 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 12 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|
| UNCAGED PLOTS | | | | | |
| FORBS | | 19.9 | 199.0 | 177.1 | |
| GRASSES | | 11.7 | 117.0 | 104.1 | |
| TOTAL UNCAGED | | 1032 | 10321 | 9186 | |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 14 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 8.3 | 83.0 | 73.9 |
| 1 | CAGED | GRASS | BROMUS TECTORUM | 17.7 | 177.0 | 157.5 |
| 1 | CAGED | GRASS | CRUCIFERAE SPECIES | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.8 | 58.0 | 51.6 |
| 1 | CAGED | GRASS | SITANION HYSTRIX | 5.5 | 55.0 | 48.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.3 | 103.0 | 91.7 |
| 2 | UNCAGED | GRASS | BROMUS TECTORUM | 11.4 | 114.0 | 101.5 |
| 2 | UNCAGED | GRASS | ELYMUS CINEREUS | 45.3 | 453.0 | 403.2 |
| 3 | CAGED | GRASS | BROMUS TECTORUM | 0.5 | 5.0 | 4.4 |
| 3 | CAGED | GRASS | SITANION HYSTRIX | 0.5 | 5.0 | 4.4 |
| 4 | UNCAGED | GRASS | BROMUS TECTORUM | 5.4 | 54.0 | 48.1 |
| 5 | UNCAGED | GRASS | BROMUS TECTORUM | 14.6 | 146.0 | 129.9 |
| 5 | UNCAGED | GRASS | SITANION HYSTRIX | 0.7 | 7.0 | 6.2 |
| 6 | CAGED | GRASS | BROMUS TECTORUM | 12.9 | 129.0 | 114.8 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 6 | CAGED | GRASS | SITANION HYSTRIX | 5.4 | 54.0 | 48.1 |
| 7 | UNCAGED | GRASS | BROMUS TECTORUM | 10.8 | 108.0 | 96.1 |
| 7 | UNCAGED | GRASS | SITANION HYSTRIX | 0.9 | 9.0 | 8.0 |
| 8 | CAGED | GRASS | BROMUS TECTORUM | 15.3 | 153.0 | 136.2 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.3 | 13.0 | 11.6 |
| 8 | CAGED | GRASS | SITANION HYSTRIX | 3.8 | 38.0 | 33.8 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 12.3 | 123.0 | 109.5 |
| 9 | UNCAGED | GRASS | BROMUS TECTORUM | 3.5 | 35.0 | 31.1 |
| 9 | UNCAGED | GRASS | SITANION HYSTRIX | 3.7 | 37.0 | 32.9 |
| 10 | CAGED | GRASS | BROMUS TECTORUM | 0.6 | 6.0 | 5.3 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.4 | 14.0 | 12.5 |
| 10 | CAGED | GRASS | SITANION HYSTRIX | 1.8 | 18.0 | 16.0 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 0.0 | 0.0 | 0.0 |
| GRASSES | 82.0 | 820.0 | 729.8 |
| TOTAL CAGED | 82.0 | 820.0 | 729.8 |
| UNCAGED PLOTS | | | |
| FORBS | 0.0 | 0.0 | 0.0 |
| GRASSES | 118.9 | 1189 | 1058 |
| TOTAL UNCAGED | 1151 | 11510 | 10244 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 15 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 25.3 | 253.0 | 225.2 |
| 1 | CAGED | GRASS | BROMUS TECTORUM | 3.1 | 31.0 | 27.6 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.8 | 138.0 | 122.8 |
| 2 | UNCAGED | GRASS | BROMUS TECTORUM | 4.9 | 49.0 | 43.6 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 24.9 | 249.0 | 221.6 |
| 3 | UNCAGED | GRASS | BROMUS TECTORUM | 1.4 | 14.0 | 12.5 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 61.9 | 619.0 | 550.9 |
| 4 | CAGED | GRASS | BROMUS TECTORUM | 5.3 | 53.0 | 47.2 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.2 | 72.0 | 64.1 |
| 4 | CAGED | GRASS | SITANION HYSTRIX | 15.2 | 152.0 | 135.3 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 14.6 | 146.0 | 129.9 |
| 5 | UNCAGED | GRASS | BROMUS TECTORUM | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 3.8 | 38.0 | 33.8 |
| 6 | CAGED | GRASS | BROMUS TECTORUM | 1.8 | 18.0 | 16.0 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 22.6 | 226.0 | 201.1 |
| 6 | CAGED | GRASS | SITANION HYSTRIX | 3.6 | 36.0 | 32.0 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.6 | 136.0 | 121.0 |
| 7 | UNCAGED | GRASS | BROMUS TECTORUM | 1.0 | 10.0 | 8.9 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.8 | 18.0 | 16.0 |
| 7 | UNCAGED | GRASS | SITANION HYSTRIX | 2.3 | 23.0 | 20.5 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 1.0 | 10.0 | 8.9 |
| 8 | UNCAGED | GRASS | BROMUS TECTORUM | 4.5 | 45.0 | 40.0 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 17.5 | 175.0 | 155.7 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 13.3 | 133.0 | 118.4 |
| 9 | CAGED | GRASS | BROMUS TECTORUM | 0.6 | 6.0 | 5.3 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 18.3 | 183.0 | 162.9 |
| 10 | CAGED | GRASS | BROMUS TECTORUM | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 22.0 | 220.0 | 195.8 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 0.0 | 0.0 | 0.0 |
| GRASSES | 204.5 | 2045 | 1820 |
| TOTAL CAGED | 204.5 | 2045 | 1820 |
| UNCAGED PLOTS | | | |
| FORBS | 1.0 | 10.0 | 8.9 |
| GRASSES | 103.2 | 1032 | 918.5 |
| TOTAL UNCAGED | 1255 | 12552 | 11171 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 16 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | PHLOX HOODII | 1.3 | 13.0 | 11.6 |
| 1 | CAGED | FORB | SALSOLA KALI | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 1.3 | 13.0 | 11.6 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | STIPA COMATA | 1.2 | 12.0 | 10.7 |
| 2 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 3.2 | 32.0 | 28.5 |
| 2 | CAGED | GRASS | CAREX SPECIES | 2.5 | 25.0 | 22.2 |
| 2 | CAGED | GRASS | POA SPECIES | 8.6 | 86.0 | 76.5 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.6 | 16.0 | 14.2 |
| 3 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 4 | CAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | HAPLOPAPPUS ACAULIS | 2.9 | 29.0 | 25.8 |
| 4 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.3 | 3.0 | 2.7 |
| 4 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 0.2 | 2.0 | 1.8 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 1.6 | 16.0 | 14.2 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.2 | 12.0 | 10.7 |
| 5 | UNCAGED | FORB | ARENARIA FENDLERI | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.2 | 52.0 | 46.3 |
| 6 | UNCAGED | FORB | ARENARIA FENDLERI | 1.0 | 10.0 | 8.9 |
| 6 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | GRASS | CAREX SPECIES | 2.0 | 20.0 | 17.8 |
| 7 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.4 | 4.0 | 3.6 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 2.7 | 27.0 | 24.0 |
| 7 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.9 | 9.0 | 8.0 |
| 7 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.8 | 8.0 | 7.1 |
| 7 | UNCAGED | FORB | TOWNSENDIA INCANA | 2.2 | 22.0 | 19.6 |
| 7 | UNCAGED | GRASS | CAREX SPECIES | 1.1 | 11.0 | 9.8 |
| 7 | UNCAGED | GRASS | POA SPECIES | 2.5 | 25.0 | 22.2 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.4 | 14.0 | 12.5 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.9 | 9.0 | 8.0 |
| 8 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.9 | 9.0 | 8.0 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | GRASS | CAREX SPECIES | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.0 | 10.0 | 8.9 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 16 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | UNCAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 9 | CAGED | FORB | ARENARIA FENDLERI | 0.8 | 8.0 | 7.1 |
| 9 | CAGED | FORB | CHAMAESYCE FENDLERI | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 1.6 | 16.0 | 14.2 |
| 9 | CAGED | FORB | PHLOX HOODII | 13.4 | 134.0 | 119.3 |
| 9 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | SENECIO MULTILOBATUS | 0.6 | 6.0 | 5.3 |
| 9 | CAGED | FORB | TOWNSENDIA INCANA | 5.0 | 50.0 | 44.5 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 9.1 | 91.0 | 81.0 |
| 9 | CAGED | GRASS | KOELERIA MACRANTHA | 1.2 | 12.0 | 10.7 |
| 9 | CAGED | GRASS | POA SPECIES | 9.7 | 97.0 | 86.3 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | PHLOX HOODII | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | POA SPECIES | 10.3 | 103.0 | 91.7 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 4.4 | 44.0 | 39.2 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 40.1 | 401.0 | 356.9 |
| GRASSES | 43.1 | 431.0 | 383.6 |
| TOTAL CAGED | 83.2 | 832.0 | 740.5 |
| UNCAGED PLOTS | | | |
| FORBS | 18.2 | 182.0 | 162.0 |
| GRASSES | 12.7 | 127.0 | 113.0 |
| TOTAL UNCAGED | 1286 | 12861 | 11446 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 17 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ARENARIA FENDLERI | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.7 | 17.0 | 15.1 |
| 1 | CAGED | FORB | PHLOX HOODII | 2.3 | 23.0 | 20.5 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 9.1 | 91.0 | 81.0 |
| 1 | CAGED | GRASS | CAREX SPECIES | 0.5 | 5.0 | 4.4 |
| 2 | UNCAGED | FORB | ARENARIA FENDLERI | 3.6 | 36.0 | 32.0 |
| 2 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.4 | 14.0 | 12.5 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 9.7 | 97.0 | 86.3 |
| 2 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 4.2 | 42.0 | 37.4 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 1.7 | 17.0 | 15.1 |
| 2 | UNCAGED | GRASS | POA SPECIES | 1.3 | 13.0 | 11.6 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 2.6 | 26.0 | 23.1 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 1.2 | 12.0 | 10.7 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.6 | 6.0 | 5.3 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | POA SPECIES | 4.6 | 46.0 | 40.9 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 0.2 | 2.0 | 1.8 |
| 4 | UNCAGED | FORB | TOWNSENDIA INCANA | 1.4 | 14.0 | 12.5 |
| 4 | UNCAGED | GRASS | CAREX SPECIES | 0.5 | 5.0 | 4.4 |
| 4 | UNCAGED | GRASS | POA SPECIES | 5.4 | 54.0 | 48.1 |
| 5 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 0.6 | 6.0 | 5.3 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | POA SPECIES | 1.6 | 16.0 | 14.2 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 9.7 | 97.0 | 86.3 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.7 | 17.0 | 15.1 |
| 7 | UNCAGED | GRASS | CAREX SPECIES | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | GRASS | POA SPECIES | 1.4 | 14.0 | 12.5 |
| 8 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.6 | 16.0 | 14.2 |
| 8 | CAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 4.6 | 46.0 | 40.9 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 4.7 | 47.0 | 41.8 |
| 9 | CAGED | GRASS | CAREX SPECIES | 0.8 | 8.0 | 7.1 |
| 9 | CAGED | GRASS | POA SPECIES | 6.5 | 65.0 | 57.8 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | FORB | PHLOX HOODII | 11.6 | 116.0 | 103.2 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.6 | 6.0 | 5.3 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 5.8 | 58.0 | 51.6 |
| 10 | CAGED | GRASS | POA SPECIES | 3.6 | 36.0 | 32.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 17 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 19.3 | 193.0 | 171.8 |
| GRASSES | 47.0 | 470.0 | 418.3 |
| TOTAL CAGED | 66.3 | 663.0 | 590.1 |
| UNCAGED PLOTS | | | |
| FORBS | 21.3 | 213.0 | 189.6 |
| GRASSES | 24.8 | 248.0 | 220.7 |
| TOTAL UNCAGED | 1332 | 13322 | 11857 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 19 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | FORB | PHLOX HOODII | 2.5 | 25.0 | 22.2 |
| 1 | CAGED | FORB | PHLOX LONGIFOLIA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | SENECIO MULTILOBATUS | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 1 | CAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.3 | 3.0 | 2.7 |
| 2 | UNCAGED | FORB | BALSAMORHIZA SAGITTATA | 2.8 | 28.0 | 24.9 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.9 | 9.0 | 8.0 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 2 | UNCAGED | GRASS | POA SPECIES | 0.8 | 8.0 | 7.1 |
| 3 | CAGED | FORB | CRYPTANTHA SERICEA | 1.4 | 14.0 | 12.5 |
| 3 | CAGED | FORB | TARAXACUM OFFICINALE | 0.9 | 9.0 | 8.0 |
| 3 | CAGED | GRASS | POA SPECIES | 9.7 | 97.0 | 86.3 |
| 4 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.2 | 2.0 | 1.8 |
| 4 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 4 | UNCAGED | GRASS | POA SPECIES | 1.1 | 11.0 | 9.8 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 12.7 | 127.0 | 113.0 |
| 5 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.6 | 6.0 | 5.3 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.0 | 10.0 | 8.9 |
| 5 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 6 | CAGED | FORB | CRYPTANTHA SERICEA | 2.9 | 29.0 | 25.8 |
| 6 | CAGED | FORB | PENSTEMON SPECIES | 0.5 | 5.0 | 4.4 |
| 6 | CAGED | FORB | SENECIO MULTILOBATUS | 1.0 | 10.0 | 8.9 |
| 6 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 6 | CAGED | GRASS | POA SPECIES | 7.0 | 70.0 | 62.3 |
| 6 | CAGED | GRASS | SITANION HYSTRIX | 0.3 | 3.0 | 2.7 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 2.0 | 20.0 | 17.8 |
| 7 | CAGED | FORB | UNKNOWN FORB | 0.5 | 5.0 | 4.4 |
| 7 | CAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 8 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 1.2 | 12.0 | 10.7 |
| 8 | UNCAGED | GRASS | CAREX SPECIES | 3.0 | 30.0 | 26.7 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 9 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.8 | 8.0 | 7.1 |
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | GRASS | CAREX SPECIES | 2.1 | 21.0 | 18.7 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.6 | 6.0 | 5.3 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | GRASS | CAREX SPECIES | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 1.1 | 11.0 | 9.8 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 19 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 10 | CAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 14.5 | 145.0 | 129.0 |
| GRASSES | 22.8 | 228.0 | 202.9 |
| TOTAL CAGED | 37.3 | 373.0 | 332.0 |
| UNCAGED PLOTS | | | |
| FORBS | 21.8 | 218.0 | 194.0 |
| GRASSES | 13.6 | 136.0 | 121.0 |
| TOTAL UNCAGED | 1368 | 13676 | 12172 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 20 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ERIGERON EATONII | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 4.1 | 41.0 | 36.5 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 8.9 | 89.0 | 79.2 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | GRASS | POA SPECIES | 3.9 | 39.0 | 34.7 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | HEDYSARUM BOREALE | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 92.9 | 929.0 | 826.8 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | HEDYSARUM BOREALE | 9.4 | 94.0 | 83.7 |
| 3 | UNCAGED | FORB | LUPINUS SPECIES | 2.6 | 26.0 | 23.1 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 5.8 | 58.0 | 51.6 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.1 | 131.0 | 116.6 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 0.4 | 4.0 | 3.6 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.3 | 3.0 | 2.7 |
| 4 | UNCAGED | FORB | LUPINUS SPECIES | 25.8 | 258.0 | 229.6 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 12.8 | 128.0 | 113.9 |
| 4 | UNCAGED | FORB | PHLOX LONGIFOLIA | 1.0 | 10.0 | 8.9 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.4 | 84.0 | 74.8 |
| 4 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.8 | 18.0 | 16.0 |
| 4 | UNCAGED | GRASS | POA SPECIES | 1.4 | 14.0 | 12.5 |
| 5 | CAGED | | DATA MISSING | . | . | . |
| 6 | CAGED | FORB | LUPINUS SPECIES | 24.2 | 242.0 | 215.4 |
| 6 | CAGED | FORB | PHLOX HOODII | 2.2 | 22.0 | 19.6 |
| 6 | CAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.3 | 3.0 | 2.7 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 19.8 | 198.0 | 176.2 |
| 7 | CAGED | | DATA MISSING | . | . | . |
| 8 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | COMANDRA UMBELLATA | 29.6 | 296.0 | 263.4 |
| 8 | UNCAGED | FORB | LUPINUS SPECIES | 3.3 | 33.0 | 29.4 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.5 | 55.0 | 48.9 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.1 | 21.0 | 18.7 |
| 8 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.5 | 15.0 | 13.3 |
| 9 | UNCAGED | FORB | ERIGERON EATONII | 1.1 | 11.0 | 9.8 |
| 9 | UNCAGED | FORB | PENSTEMON SPECIES | 2.7 | 27.0 | 24.0 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 10.7 | 107.0 | 95.2 |
| 9 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | TRIFOLIUM GYMNOCARPON | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.8 | 28.0 | 24.9 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.6 | 36.0 | 32.0 |
| 9 | UNCAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 6.8 | 68.0 | 60.5 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 20 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 10 | CAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | FORB | LUPINUS SPECIES | 2.9 | 29.0 | 25.8 |
| 10 | CAGED | FORB | PENSTEMON SPECIES | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | PHLOX HOODII | 8.6 | 86.0 | 76.5 |
| 10 | CAGED | FORB | PHLOX LONGIFOLIA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 2.8 | 28.0 | 24.9 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 2.0 | 20.0 | 17.8 |
| 10 | CAGED | GRASS | POA SPECIES | 3.9 | 39.0 | 34.7 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 52.7 | 527.0 | 469.0 |
| GRASSES | 41.7 | 417.0 | 371.1 |
| TOTAL CAGED | 94.4 | 944.0 | 840.2 |
| UNCAGED PLOTS | | | |
| FORBS | 201.0 | 2010 | 1789 |
| GRASSES | 47.3 | 473.0 | 421.0 |
| TOTAL UNCAGED | 1616 | 16159 | 14382 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 22 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | COMANDRA UMBELLATA | 7.4 | 74.0 | 65.9 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 5.4 | 54.0 | 48.1 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 3.0 | 30.0 | 26.7 |
| 1 | CAGED | GRASS | STIPA COMATA | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | FORB | COMANDRA UMBELLATA | 8.9 | 89.0 | 79.2 |
| 2 | UNCAGED | FORB | HEDYSARUM BOREALE | 5.6 | 56.0 | 49.8 |
| 2 | UNCAGED | FORB | UNKNOWN FORB | 0.7 | 7.0 | 6.2 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 2.4 | 24.0 | 21.4 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.7 | 7.0 | 6.2 |
| 2 | UNCAGED | GRASS | STIPA COMATA | 11.2 | 112.0 | 99.7 |
| 3 | UNCAGED | FORB | COMANDRA UMBELLATA | 1.4 | 14.0 | 12.5 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 2.1 | 21.0 | 18.7 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.4 | 54.0 | 48.1 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.5 | 25.0 | 22.2 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.9 | 9.0 | 8.0 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 1.9 | 19.0 | 16.9 |
| 4 | CAGED | FORB | HEDYSARUM BOREALE | 7.4 | 74.0 | 65.9 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 4.8 | 48.0 | 42.7 |
| 4 | CAGED | GRASS | CAREX SPECIES | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 1.7 | 17.0 | 15.1 |
| 4 | CAGED | GRASS | STIPA COMATA | 4.7 | 47.0 | 41.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.9 | 19.0 | 16.9 |
| 5 | UNCAGED | GRASS | BROMUS TECTORUM | 1.4 | 14.0 | 12.5 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.5 | 25.0 | 22.2 |
| 5 | UNCAGED | GRASS | POA SPECIES | 2.6 | 26.0 | 23.1 |
| 5 | UNCAGED | GRASS | STIPA COMATA | 3.4 | 34.0 | 30.3 |
| 6 | UNCAGED | FORB | UNKNOWN FORB | 3.6 | 36.0 | 32.0 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.4 | 84.0 | 74.8 |
| 6 | UNCAGED | GRASS | BROMUS TECTORUM | 0.2 | 2.0 | 1.8 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 6.3 | 63.0 | 56.1 |
| 6 | UNCAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 6 | UNCAGED | GRASS | STIPA COMATA | 5.9 | 59.0 | 52.5 |
| 7 | UNCAGED | FORB | HEDYSARUM BOREALE | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 1.8 | 18.0 | 16.0 |
| 7 | UNCAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 8.1 | 81.0 | 72.1 |
| 7 | UNCAGED | GRASS | BROMUS TECTORUM | 1.7 | 17.0 | 15.1 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.5 | 35.0 | 31.1 |
| 7 | UNCAGED | GRASS | STIPA COMATA | 2.7 | 27.0 | 24.0 |
| 8 | CAGED | FORB | ERIGERON EATONII | 0.3 | 3.0 | 2.7 |
| 8 | CAGED | FORB | HEDYSARUM BOREALE | 4.8 | 48.0 | 42.7 |
| 8 | CAGED | FORB | IPOMOPSIS AGGREGATA | 2.6 | 26.0 | 23.1 |
| 8 | CAGED | FORB | UNKNOWN FORB | 1.1 | 11.0 | 9.8 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 8 | CAGED | GRASS | BROMUS TECTORUM | 1.2 | 12.0 | 10.7 |
| 8 | CAGED | GRASS | CAREX SPECIES | 0.4 | 4.0 | 3.6 |
| 8 | CAGED | GRASS | KOELERIA MACRANTHA | 7.7 | 77.0 | 68.5 |
| 8 | CAGED | GRASS | POA SPECIES | 10.0 | 100.0 | 89.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 22 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | CAGED | GRASS | STIPA COMATA | 2.2 | 22.0 | 19.6 |
| 9 | CAGED | FORB | BALSAMORHIZA SAGITTATA | 29.9 | 299.0 | 266.1 |
| 9 | CAGED | FORB | ERIGERON EATONII | 1.3 | 13.0 | 11.6 |
| 9 | CAGED | FORB | HEDYSARUM BOREALE | 3.2 | 32.0 | 28.5 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 5.9 | 59.0 | 52.5 |
| 9 | CAGED | GRASS | BROMUS TECTORUM | 1.1 | 11.0 | 9.8 |
| 9 | CAGED | GRASS | KOELERIA MACRANTHA | 3.5 | 35.0 | 31.1 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 9 | CAGED | GRASS | POA SPECIES | 5.1 | 51.0 | 45.4 |
| 9 | CAGED | GRASS | STIPA COMATA | 1.3 | 13.0 | 11.6 |
| 10 | CAGED | FORB | COMANDRA UMBELLATA | 2.6 | 26.0 | 23.1 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 4.1 | 41.0 | 36.5 |
| 10 | CAGED | GRASS | CAREX SPECIES | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 3.2 | 32.0 | 28.5 |
| 10 | CAGED | GRASS | POA SPECIES | 8.1 | 81.0 | 72.1 |
| 10 | CAGED | GRASS | STIPA COMATA | 4.0 | 40.0 | 35.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 61.2 | 612.0 | 544.7 |
| GRASSES | 81.5 | 815.0 | 725.3 |
| TOTAL CAGED | 142.7 | 1427 | 1270 |
| UNCAGED PLOTS | | | |
| FORBS | 25.5 | 255.0 | 226.9 |
| GRASSES | 76.5 | 765.0 | 680.8 |
| TOTAL UNCAGED | 1718 | 17179 | 15289 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 28 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 35.5 | 355.0 | 315.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.4 | 34.0 | 30.3 |
| 2 | UNCAGED | GRASS | BROMUS TECTORUM | 16.0 | 160.0 | 142.4 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 40.7 | 407.0 | 362.2 |
| 3 | CAGED | GRASS | BROMUS TECTORUM | 21.1 | 211.0 | 187.8 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 3.9 | 39.0 | 34.7 |
| 4 | CAGED | GRASS | BROMUS TECTORUM | 43.9 | 439.0 | 390.7 |
| 5 | UNCAGED | GRASS | BROMUS TECTORUM | 27.3 | 273.0 | 243.0 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.2 | 52.0 | 46.3 |
| 6 | UNCAGED | GRASS | BROMUS TECTORUM | 44.4 | 444.0 | 395.2 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 13.4 | 134.0 | 119.3 |
| 7 | CAGED | GRASS | BROMUS TECTORUM | 1.9 | 19.0 | 16.9 |
| 7 | CAGED | GRASS | POA SPECIES | 0.9 | 9.0 | 8.0 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 8 | UNCAGED | GRASS | BROMUS TECTORUM | 14.7 | 147.0 | 130.8 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | GRASS | SITANION HYSTRIX | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | GRASS | BROMUS TECTORUM | 13.3 | 133.0 | 118.4 |
| 9 | UNCAGED | GRASS | SITANION HYSTRIX | 1.5 | 15.0 | 13.3 |
| 10 | CAGED | GRASS | BROMUS TECTORUM | 4.0 | 40.0 | 35.6 |
| 10 | CAGED | GRASS | SITANION HYSTRIX | 3.0 | 30.0 | 26.7 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 0.0 | 0.0 | 0.0 |
| GRASSES | 168.3 | 1683 | 1498 |
| TOTAL CAGED | 168.3 | 1683 | 1498 |
| UNCAGED PLOTS | | | |
| FORBS | 0.0 | 0.0 | 0.0 |
| GRASSES | 129.7 | 1297 | 1154 |
| TOTAL UNCAGED | 1848 | 18476 | 16444 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 30 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.3 | 3.0 | 2.7 |
| 1 | CAGED | FORB | PHLOX HOODII | 6.9 | 69.0 | 61.4 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 14.0 | 140.0 | 124.6 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.9 | 39.0 | 34.7 |
| 1 | CAGED | GRASS | STIPA COMATA | 2.9 | 29.0 | 25.8 |
| 2 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 2 | UNCAGED | GRASS | STIPA COMATA | 2.5 | 25.0 | 22.2 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.6 | 16.0 | 14.2 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.1 | 31.0 | 27.6 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 11.2 | 112.0 | 99.7 |
| 4 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 4 | UNCAGED | GRASS | BROMUS TECTORUM | 7.5 | 75.0 | 66.7 |
| 4 | UNCAGED | GRASS | POA SPECIES | 0.6 | 6.0 | 5.3 |
| 4 | UNCAGED | GRASS | SITANION HYSTRIX | 2.9 | 29.0 | 25.8 |
| 5 | CAGED | FORB | HEDYSARUM BOREALE | 5.1 | 51.0 | 45.4 |
| 5 | CAGED | GRASS | AGROPYRON SPECIES | 12.3 | 123.0 | 109.5 |
| 5 | CAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 5 | CAGED | GRASS | SITANION HYSTRIX | 2.4 | 24.0 | 21.4 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 3.8 | 38.0 | 33.8 |
| 6 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.6 | 6.0 | 5.3 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 12.3 | 123.0 | 109.5 |
| 6 | UNCAGED | GRASS | SITANION HYSTRIX | 4.2 | 42.0 | 37.4 |
| 7 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | GRASS | SITANION HYSTRIX | 1.4 | 14.0 | 12.5 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 0.4 | 4.0 | 3.6 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.7 | 27.0 | 24.0 |
| 9 | CAGED | FORB | CRUCIFERAE SPECIES | 0.4 | 4.0 | 3.6 |
| 9 | CAGED | FORB | PHLOX HOODII | 0.7 | 7.0 | 6.2 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.4 | 14.0 | 12.5 |
| 9 | CAGED | GRASS | POA SPECIES | 0.9 | 9.0 | 8.0 |
| 9 | CAGED | GRASS | SITANION HYSTRIX | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | POA SPECIES | 2.2 | 22.0 | 19.6 |
| 10 | CAGED | GRASS | SITANION HYSTRIX | 0.7 | 7.0 | 6.2 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 13.5 | 135.0 | 120.1 |
| GRASSES | 42.8 | 428.0 | 380.9 |
| TOTAL CAGED | 56.3 | 563.0 | 501.1 |
| UNCAGED PLOTS | | | |
| FORBS | 9.4 | 94.0 | 83.7 |
| GRASSES | 54.4 | 544.0 | 484.2 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 30 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|---|
| TOTAL | UNCAGED | | 1911 | 19114 | | 17011 | |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 31 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | BALSAMORHIZA SAGITTATA | 0.3 | 3.0 | 2.7 |
| 1 | CAGED | FORB | COMANDRA UMBELLATA | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | ERIGERON EATONII | 1.7 | 17.0 | 15.1 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 4.8 | 48.0 | 42.7 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 11.8 | 118.0 | 105.0 |
| 1 | CAGED | FORB | IPOMOPSIS AGGREGATA | 7.0 | 70.0 | 62.3 |
| 1 | CAGED | FORB | LUPINUS ARGENTEUS | 1.4 | 14.0 | 12.5 |
| 1 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | GRASS | CAREX SPECIES | 6.0 | 60.0 | 53.4 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 21.4 | 214.0 | 190.5 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 1.2 | 12.0 | 10.7 |
| 2 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 55.8 | 558.0 | 496.6 |
| 2 | UNCAGED | FORB | HEDYSARUM BOREALE | 7.8 | 78.0 | 69.4 |
| 2 | UNCAGED | FORB | LINUM LEWISII | 0.5 | 5.0 | 4.4 |
| 2 | UNCAGED | FORB | LUPINUS ARGENTEUS | 7.6 | 76.0 | 67.6 |
| 2 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.7 | 7.0 | 6.2 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.3 | 3.0 | 2.7 |
| 2 | UNCAGED | FORB | UNKNOWN FORB | 2.3 | 23.0 | 20.5 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.3 | 13.0 | 11.6 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 11.1 | 111.0 | 98.8 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 3 | CAGED | FORB | ASTRAGALUS PURSHII | 0.2 | 2.0 | 1.8 |
| 3 | CAGED | FORB | COMANDRA UMBELLATA | 0.4 | 4.0 | 3.6 |
| 3 | CAGED | FORB | ERIGERON EATONII | 2.5 | 25.0 | 22.2 |
| 3 | CAGED | FORB | ERIOGONUM UMBELLATUM | 6.3 | 63.0 | 56.1 |
| 3 | CAGED | FORB | HEDYSARUM BOREALE | 3.6 | 36.0 | 32.0 |
| 3 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.5 | 15.0 | 13.3 |
| 3 | CAGED | FORB | LINUM LEWISII | 0.6 | 6.0 | 5.3 |
| 3 | CAGED | FORB | LUPINUS ARGENTEUS | 14.5 | 145.0 | 129.0 |
| 3 | CAGED | FORB | TOWNSENDIA INCANA | 5.1 | 51.0 | 45.4 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 4.1 | 41.0 | 36.5 |
| 3 | CAGED | GRASS | CAREX SPECIES | 0.4 | 4.0 | 3.6 |
| 3 | CAGED | GRASS | KOELERIA MACRANTHA | 2.2 | 22.0 | 19.6 |
| 3 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 4.0 | 40.0 | 35.6 |
| 3 | CAGED | GRASS | POA SPECIES | 3.6 | 36.0 | 32.0 |
| 4 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 4.2 | 42.0 | 37.4 |
| 4 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 4 | UNCAGED | GRASS | POA SPECIES | 3.3 | 33.0 | 29.4 |
| 5 | UNCAGED | FORB | ACHILLEA LANULOSA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.7 | 7.0 | 6.2 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | FORB | ERIGERON EATONII | 1.0 | 10.0 | 8.9 |
| 5 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 5.8 | 58.0 | 51.6 |
| 5 | UNCAGED | FORB | HEDYSARUM BOREALE | 2.7 | 27.0 | 24.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 31 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 5 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | LINUM LEWISII | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | PENSTEMON SPECIES | 1.8 | 18.0 | 16.0 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 4.7 | 47.0 | 41.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.8 | 78.0 | 69.4 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 1.6 | 16.0 | 14.2 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.7 | 37.0 | 32.9 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.3 | 23.0 | 20.5 |
| 5 | UNCAGED | GRASS | POA SPECIES | 7.8 | 78.0 | 69.4 |
| 6 | CAGED | FORB | COMANDRA UMBELLATA | 9.5 | 95.0 | 84.5 |
| 6 | CAGED | FORB | CRUCIFERAE SPECIES | 0.4 | 4.0 | 3.6 |
| 6 | CAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 6 | CAGED | FORB | ERIGERON EATONII | 0.4 | 4.0 | 3.6 |
| 6 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.3 | 13.0 | 11.6 |
| 6 | CAGED | FORB | HEDYSARUM BOREALE | 11.5 | 115.0 | 102.3 |
| 6 | CAGED | FORB | IPOMOPSIS AGGREGATA | 6.7 | 67.0 | 59.6 |
| 6 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 1.3 | 13.0 | 11.6 |
| 6 | CAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 7.9 | 79.0 | 70.3 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 10.4 | 104.0 | 92.6 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.3 | 23.0 | 20.5 |
| 6 | CAGED | GRASS | POA SPECIES | 1.8 | 18.0 | 16.0 |
| 7 | CAGED | FORB | ACHILLEA LANULOSA | 1.0 | 10.0 | 8.9 |
| 7 | CAGED | FORB | BALSAMORHIZA SAGITTATA | 2.7 | 27.0 | 24.0 |
| 7 | CAGED | FORB | COMANDRA UMBELLATA | 8.7 | 87.0 | 77.4 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | ERIOGONUM UMBELLATUM | 7.0 | 70.0 | 62.3 |
| 7 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.3 | 13.0 | 11.6 |
| 7 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.3 | 3.0 | 2.7 |
| 7 | CAGED | FORB | PENSTEMON SPECIES | 0.2 | 2.0 | 1.8 |
| 7 | CAGED | FORB | SENECIO MULTILOBATUS | 1.1 | 11.0 | 9.8 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 6.1 | 61.0 | 54.3 |
| 7 | CAGED | GRASS | KOELERIA MACRANTHA | 0.5 | 5.0 | 4.4 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 7 | CAGED | GRASS | STIPA COMATA | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | COMANDRA UMBELLATA | 12.7 | 127.0 | 113.0 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | ERIGERON EATONII | 10.3 | 103.0 | 91.7 |
| 8 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 4.1 | 41.0 | 36.5 |
| 8 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.3 | 3.0 | 2.7 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 8.3 | 83.0 | 73.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 4.9 | 49.0 | 43.6 |
| 8 | UNCAGED | GRASS | POA SPECIES | 1.8 | 18.0 | 16.0 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 2.6 | 26.0 | 23.1 |
| 9 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | COMANDRA UMBELLATA | 15.9 | 159.0 | 141.5 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 31 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 9 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | ERIGERON EATONII | 1.4 | 14.0 | 12.5 |
| 9 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 14.3 | 143.0 | 127.3 |
| 9 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 2.5 | 25.0 | 22.2 |
| 9 | UNCAGED | FORB | LINUM LEWISII | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | LUPINUS ARGENTEUS | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 32.8 | 328.0 | 291.9 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 7.9 | 79.0 | 70.3 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | COMANDRA UMBELLATA | 13.2 | 132.0 | 117.5 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 3.3 | 33.0 | 29.4 |
| 10 | CAGED | FORB | ERIGERON EATONII | 1.6 | 16.0 | 14.2 |
| 10 | CAGED | FORB | ERIOGONUM UMBELLATUM | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | TOWNSENDIA INCANA | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 39.0 | 390.0 | 347.1 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 137.1 | 1371 | 1220 |
| GRASSES | 90.6 | 906.0 | 806.3 |
| TOTAL CAGED | 227.7 | 2277 | 2027 |
| UNCAGED PLOTS | | | |
| FORBS | 194.6 | 1946 | 1732 |
| GRASSES | 94.7 | 947.0 | 842.8 |
| TOTAL UNCAGED | 2201 | 22007 | 19586 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 32 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.1 | 11.0 | 9.8 |
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.7 | 7.0 | 6.2 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 0.7 | 7.0 | 6.2 |
| 1 | CAGED | FORB | ERIGERON EATONII | 1.2 | 12.0 | 10.7 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 2.2 | 22.0 | 19.6 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 36.5 | 365.0 | 324.8 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 4.4 | 44.0 | 39.2 |
| 1 | CAGED | GRASS | POA SPECIES | 12.6 | 126.0 | 112.1 |
| 2 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.3 | 13.0 | 11.6 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 1.3 | 13.0 | 11.6 |
| 2 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 3.6 | 36.0 | 32.0 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 13.3 | 133.0 | 118.4 |
| 2 | UNCAGED | FORB | UNKNOWN FORB | 3.1 | 31.0 | 27.6 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.7 | 37.0 | 32.9 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 18.3 | 183.0 | 162.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 6.4 | 64.0 | 57.0 |
| 3 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.0 | 10.0 | 8.9 |
| 3 | CAGED | FORB | CRUCIFERAE SPECIES | 1.0 | 10.0 | 8.9 |
| 3 | CAGED | FORB | ERIGERON EATONII | 1.5 | 15.0 | 13.3 |
| 3 | CAGED | FORB | TOWNSENDIA INCANA | 4.4 | 44.0 | 39.2 |
| 3 | CAGED | FORB | UNKNOWN FORB | 0.6 | 6.0 | 5.3 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 25.5 | 255.0 | 226.9 |
| 3 | CAGED | GRASS | KOELERIA MACRANTHA | 5.0 | 50.0 | 44.5 |
| 3 | CAGED | GRASS | POA SPECIES | 1.9 | 19.0 | 16.9 |
| 4 | CAGED | FORB | ERIGERON EATONII | 1.2 | 12.0 | 10.7 |
| 4 | CAGED | FORB | ERIOGONUM UMBELLATUM | 4.7 | 47.0 | 41.8 |
| 4 | CAGED | FORB | LITHOSPERMUM SPECIES | 26.6 | 266.0 | 236.7 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 19.3 | 193.0 | 171.8 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 8.7 | 87.0 | 77.4 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 2.6 | 26.0 | 23.1 |
| 4 | CAGED | GRASS | POA SPECIES | 18.4 | 184.0 | 163.8 |
| 5 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 7.3 | 73.0 | 65.0 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 4.6 | 46.0 | 40.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.4 | 54.0 | 48.1 |
| 5 | UNCAGED | GRASS | POA SPECIES | 6.6 | 66.0 | 58.7 |
| 6 | UNCAGED | FORB | ACHILLEA LANULOSA | 0.6 | 6.0 | 5.3 |
| 6 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.5 | 5.0 | 4.4 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.5 | 15.0 | 13.3 |
| 6 | UNCAGED | FORB | ERIGERON EATONII | 1.3 | 13.0 | 11.6 |
| 6 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 24.3 | 243.0 | 216.3 |
| 6 | UNCAGED | FORB | TOWNSENDIA INCANA | 8.6 | 86.0 | 76.5 |
| 6 | UNCAGED | FORB | UNKNOWN FORB | 0.9 | 9.0 | 8.0 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.1 | 101.0 | 89.9 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.7 | 7.0 | 6.2 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 19.2 | 192.0 | 170.9 |
| 6 | UNCAGED | GRASS | POA SPECIES | 3.2 | 32.0 | 28.5 |
| 7 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 2.2 | 22.0 | 19.6 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 32 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 7 | CAGED | FORB | CRUCIFERAE SPECIES | 0.9 | 9.0 | 8.0 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 5.3 | 53.0 | 47.2 |
| 7 | CAGED | FORB | ERIGERON EATONII | 1.9 | 19.0 | 16.9 |
| 7 | CAGED | FORB | ERIOGONUM UMBELLATUM | 9.0 | 90.0 | 80.1 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 22.1 | 221.0 | 196.7 |
| 7 | CAGED | GRASS | KOELERIA MACRANTHA | 0.9 | 9.0 | 8.0 |
| 7 | CAGED | GRASS | POA SPECIES | 13.2 | 132.0 | 117.5 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 1.5 | 15.0 | 13.3 |
| 8 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 3.9 | 39.0 | 34.7 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 17.1 | 171.0 | 152.2 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | GRASS | POA SPECIES | 3.5 | 35.0 | 31.1 |
| 9 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.8 | 8.0 | 7.1 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.7 | 17.0 | 15.1 |
| 9 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 2.4 | 24.0 | 21.4 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.5 | 105.0 | 93.4 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 4.5 | 45.0 | 40.0 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.9 | 89.0 | 79.2 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.9 | 9.0 | 8.0 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 1.0 | 10.0 | 8.9 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.8 | 8.0 | 7.1 |
| 10 | CAGED | FORB | SENECIO MULTILOBATUS | 2.7 | 27.0 | 24.0 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 9.0 | 90.0 | 80.1 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 1.4 | 14.0 | 12.5 |
| 10 | CAGED | GRASS | POA SPECIES | 5.4 | 54.0 | 48.1 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 128.1 | 1281 | 1140 |
| GRASSES | 132.6 | 1326 | 1180 |
| TOTAL CAGED | 260.7 | 2607 | 2320 |
| UNCAGED PLOTS | | | |
| FORBS | 84.1 | 841.0 | 748.5 |
| GRASSES | 119.2 | 1192 | 1061 |
| TOTAL UNCAGED | 2404 | 24040 | 21396 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 33 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 26.8 | 268.0 | 238.5 |
| 1 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.8 | 8.0 | 7.1 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.2 | 22.0 | 19.6 |
| 2 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.6 | 6.0 | 5.3 |
| 2 | UNCAGED | FORB | LUPINUS ARGENTEUS | 10.1 | 101.0 | 89.9 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 7.9 | 79.0 | 70.3 |
| 2 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.3 | 13.0 | 11.6 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 12.6 | 126.0 | 112.1 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.2 | 52.0 | 46.3 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.1 | 11.0 | 9.8 |
| 3 | UNCAGED | FORB | COMANDRA UMBELLATA | 1.2 | 12.0 | 10.7 |
| 3 | UNCAGED | FORB | HEDYSARUM BOREALE | 43.4 | 434.0 | 386.3 |
| 3 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 6.5 | 65.0 | 57.8 |
| 3 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.1 | 11.0 | 9.8 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 15.1 | 151.0 | 134.4 |
| 4 | CAGED | FORB | COMANDRA UMBELLATA | 17.1 | 171.0 | 152.2 |
| 4 | CAGED | FORB | LUPINUS ARGENTEUS | 8.2 | 82.0 | 73.0 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 4.7 | 47.0 | 41.8 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.2 | 22.0 | 19.6 |
| 5 | CAGED | FORB | COMANDRA UMBELLATA | 2.2 | 22.0 | 19.6 |
| 5 | CAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 5 | CAGED | FORB | HEDYSARUM BOREALE | 57.3 | 573.0 | 510.0 |
| 5 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.8 | 8.0 | 7.1 |
| 5 | CAGED | FORB | TOWNSENDIA INCANA | 12.9 | 129.0 | 114.8 |
| 5 | CAGED | FORB | UNKNOWN FORB | 0.6 | 6.0 | 5.3 |
| 5 | CAGED | GRASS | AGROPYRON SPECIES | 5.7 | 57.0 | 50.7 |
| 5 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.0 | 80.0 | 71.2 |
| 6 | UNCAGED | FORB | COMANDRA UMBELLATA | 2.0 | 20.0 | 17.8 |
| 6 | UNCAGED | FORB | ERIGERON EATONII | 0.7 | 7.0 | 6.2 |
| 6 | UNCAGED | FORB | HEDYSARUM BOREALE | 44.8 | 448.0 | 398.7 |
| 6 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 6 | UNCAGED | FORB | TOWNSENDIA INCANA | 8.4 | 84.0 | 74.8 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.5 | 5.0 | 4.4 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.2 | 22.0 | 19.6 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 20.2 | 202.0 | 179.8 |
| 6 | UNCAGED | GRASS | POA SPECIES | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | FORB | CHAENACTIS DOUGLASII | 0.9 | 9.0 | 8.0 |
| 7 | UNCAGED | FORB | COMANDRA UMBELLATA | 1.3 | 13.0 | 11.6 |
| 7 | UNCAGED | FORB | ERIGERON EATONII | 0.8 | 8.0 | 7.1 |
| 7 | UNCAGED | FORB | HEDYSARUM BOREALE | 30.7 | 307.0 | 273.2 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 7.8 | 78.0 | 69.4 |
| 7 | UNCAGED | FORB | TOWNSENDIA INCANA | 4.6 | 46.0 | 40.9 |
| 7 | UNCAGED | FORB | UNKNOWN FORB | 0.7 | 7.0 | 6.2 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.7 | 17.0 | 15.1 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.7 | 17.0 | 15.1 |
| 7 | UNCAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 8 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 4.0 | 40.0 | 35.6 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 33 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | UNCAGED | FORB | COMANDRA UMBELLATA | 2.3 | 23.0 | 20.5 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | FORB | TARAXACUM OFFICINALE | 1.9 | 19.0 | 16.9 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.5 | 5.0 | 4.4 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 27.6 | 276.0 | 245.6 |
| 8 | UNCAGED | GRASS | POA SPECIES | 2.5 | 25.0 | 22.2 |
| 8 | UNCAGED | GRASS | SITANION HYSTRIX | 0.5 | 5.0 | 4.4 |
| 9 | CAGED | FORB | COMANDRA UMBELLATA | 3.6 | 36.0 | 32.0 |
| 9 | CAGED | FORB | CREPIS OCCIDENTALIS | 2.6 | 26.0 | 23.1 |
| 9 | CAGED | FORB | CRUCIFERAE SPECIES | 0.6 | 6.0 | 5.3 |
| 9 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.6 | 6.0 | 5.3 |
| 9 | CAGED | FORB | HEDYSARUM BOREALE | 8.1 | 81.0 | 72.1 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 16.3 | 163.0 | 145.1 |
| 9 | CAGED | GRASS | POA SPECIES | 10.4 | 104.0 | 92.6 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 4.2 | 42.0 | 37.4 |
| 10 | CAGED | FORB | ERIGERON EATONII | 2.4 | 24.0 | 21.4 |
| 10 | CAGED | FORB | LUPINUS ARGENTEUS | 22.2 | 222.0 | 197.6 |
| 10 | CAGED | FORB | TOWNSENDIA INCANA | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 179.3 | 1793 | 1596 |
| GRASSES | 48.9 | 489.0 | 435.2 |
| TOTAL CAGED | 228.2 | 2282 | 2031 |
| UNCAGED PLOTS | | | |
| FORBS | 198.2 | 1982 | 1764 |
| GRASSES | 82.2 | 822.0 | 731.6 |
| TOTAL UNCAGED | 2684 | 26844 | 23891 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 34 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 3.0 | 30.0 | 26.7 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 15.3 | 153.0 | 136.2 |
| 1 | CAGED | FORB | LINUM LEWISII | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 0.7 | 7.0 | 6.2 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.1 | 61.0 | 54.3 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 2.1 | 21.0 | 18.7 |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.3 | 13.0 | 11.6 |
| 3 | UNCAGED | FORB | TOWNSENDIA INCANA | 4.1 | 41.0 | 36.5 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.0 | 30.0 | 26.7 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |
| 4 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 1.1 | 11.0 | 9.8 |
| 4 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 0.3 | 3.0 | 2.7 |
| 4 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 11.8 | 118.0 | 105.0 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 6.5 | 65.0 | 57.8 |
| 4 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.3 | 3.0 | 2.7 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 9.1 | 91.0 | 81.0 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 5 | CAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 5 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 2.7 | 27.0 | 24.0 |
| 5 | CAGED | FORB | PHLOX HOODII | 0.5 | 5.0 | 4.4 |
| 5 | CAGED | FORB | TOWNSENDIA INCANA | 2.1 | 21.0 | 18.7 |
| 6 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.8 | 8.0 | 7.1 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 3.3 | 33.0 | 29.4 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 98.5 | 985.0 | 876.6 |
| 6 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 5.0 | 50.0 | 44.5 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 12.7 | 127.0 | 113.0 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 21.4 | 214.0 | 190.5 |
| 7 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.4 | 4.0 | 3.6 |
| 7 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.8 | 8.0 | 7.1 |
| 7 | CAGED | FORB | TOWNSENDIA INCANA | 0.8 | 8.0 | 7.1 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 13.1 | 131.0 | 116.6 |
| 8 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 9 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.7 | 7.0 | 6.2 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 9 | CAGED | FORB | ERIOGONUM UMBELLATUM | 11.3 | 113.0 | 100.6 |
| 9 | CAGED | FORB | PHLOX HOODII | 8.3 | 83.0 | 73.9 |
| 9 | CAGED | FORB | TOWNSENDIA INCANA | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 4.0 | 40.0 | 35.6 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.4 | 64.0 | 57.0 |
| 10 | CAGED | FORB | HEDYSARUM BOREALE | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | PHLOX HOODII | 26.9 | 269.0 | 239.4 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 19.0 | 190.0 | 169.1 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 34 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 77.0 | 770.0 | 685.3 |
| GRASSES | 48.6 | 486.0 | 432.5 |
| TOTAL CAGED | 125.6 | 1256 | 1118 |
| UNCAGED PLOTS | | | |
| FORBS | 136.5 | 1365 | 1215 |
| GRASSES | 48.6 | 486.0 | 432.5 |
| TOTAL UNCAGED | 2869 | 28695 | 25539 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 35 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 2.9 | 29.0 | 25.8 |
| 1 | CAGED | FORB | ERIOGONUM UMBELLATUM | 3.2 | 32.0 | 28.5 |
| 1 | CAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 28.7 | 287.0 | 255.4 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 1.3 | 13.0 | 11.6 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.8 | 18.0 | 16.0 |
| 2 | CAGED | FORB | ERIOGONUM UMBELLATUM | 5.4 | 54.0 | 48.1 |
| 2 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.5 | 15.0 | 13.3 |
| 2 | CAGED | FORB | TOWNSENDIA INCANA | 3.0 | 30.0 | 26.7 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 17.1 | 171.0 | 152.2 |
| 2 | CAGED | GRASS | KOELERIA MACRANTHA | 1.3 | 13.0 | 11.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 3 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 4.2 | 42.0 | 37.4 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 4 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 2.6 | 26.0 | 23.1 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.1 | 31.0 | 27.6 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.2 | 12.0 | 10.7 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.7 | 17.0 | 15.1 |
| 5 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 1.5 | 15.0 | 13.3 |
| 5 | UNCAGED | FORB | LINUM LEWISII | 0.9 | 9.0 | 8.0 |
| 5 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 4.2 | 42.0 | 37.4 |
| 5 | UNCAGED | FORB | TOWNSENDIA INCANA | 2.1 | 21.0 | 18.7 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 29.2 | 292.0 | 259.9 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.4 | 24.0 | 21.4 |
| 6 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.7 | 7.0 | 6.2 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.0 | 10.0 | 8.9 |
| 6 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | FORB | LINUM LEWISII | 0.2 | 2.0 | 1.8 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 33.7 | 337.0 | 299.9 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.3 | 23.0 | 20.5 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.7 | 17.0 | 15.1 |
| 7 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 3.0 | 30.0 | 26.7 |
| 7 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | ERIOGONUM UMBELLATUM | 21.3 | 213.0 | 189.6 |
| 7 | CAGED | FORB | LINUM LEWISII | 5.5 | 55.0 | 48.9 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 13.9 | 139.0 | 123.7 |
| 7 | CAGED | GRASS | KOELERIA MACRANTHA | 4.8 | 48.0 | 42.7 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.4 | 24.0 | 21.4 |
| 7 | CAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 8 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 3.0 | 30.0 | 26.7 |
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.3 | 13.0 | 11.6 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.8 | 38.0 | 33.8 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | FORB | ERIOGONUM UMBELLATUM | 18.2 | 182.0 | 162.0 |
| 9 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | FORB | HEDYSARUM BOREALE | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 35 VEGETATION TYPE= MIXED BRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | TOWNSENDIA INCANA | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.4 | 74.0 | 65.9 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 6.4 | 64.0 | 57.0 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.4 | 4.0 | 3.6 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 6.9 | 69.0 | 61.4 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.2 | 12.0 | 10.7 |
| 10 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | LINUM LEWISII | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 12.3 | 123.0 | 109.5 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 1.6 | 16.0 | 14.2 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.3 | 33.0 | 29.4 |
| 10 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 52.0 | 520.0 | 462.8 |
| GRASSES | 90.6 | 906.0 | 806.3 |
| TOTAL CAGED | 142.6 | 1426 | 1269 |
| UNCAGED PLOTS | | | |
| FORBS | 39.7 | 397.0 | 353.3 |
| GRASSES | 99.3 | 993.0 | 883.8 |
| TOTAL UNCAGED | 3008 | 30085 | 26776 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 36 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 1.9 | 19.0 | 16.9 |
| 2 | UNCAGED | FORB | UNKNOWN FORB | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.9 | 19.0 | 16.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 3.6 | 36.0 | 32.0 |
| 3 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 2.5 | 25.0 | 22.2 |
| 3 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 3 | CAGED | GRASS | CAREX SPECIES | 1.2 | 12.0 | 10.7 |
| 3 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.9 | 29.0 | 25.8 |
| 4 | UNCAGED | FORB | BALSAMORHIZA SAGITTATA | 104.6 | 1046 | 930.9 |
| 4 | UNCAGED | FORB | COMANDRA UMBELLATA | 11.9 | 119.0 | 105.9 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.8 | 18.0 | 16.0 |
| 4 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.8 | 18.0 | 16.0 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 5 | UNCAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 6 | CAGED | FORB | COMANDRA UMBELLATA | 5.5 | 55.0 | 48.9 |
| 6 | CAGED | FORB | ERIOGONUM UMBELLATUM | 0.5 | 5.0 | 4.4 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 0.7 | 7.0 | 6.2 |
| 6 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.7 | 17.0 | 15.1 |
| 6 | CAGED | GRASS | POA SPECIES | 2.3 | 23.0 | 20.5 |
| 7 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.7 | 7.0 | 6.2 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 25.9 | 259.0 | 230.5 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 9.4 | 94.0 | 83.7 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.4 | 4.0 | 3.6 |
| 8 | CAGED | FORB | ASTRAGALUS PURSHII | 0.7 | 7.0 | 6.2 |
| 8 | CAGED | FORB | CRYPTANTHA SERICEA | 0.6 | 6.0 | 5.3 |
| 8 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 1.7 | 17.0 | 15.1 |
| 8 | CAGED | FORB | PHLOX HOODII | 17.9 | 179.0 | 159.3 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 0.6 | 6.0 | 5.3 |
| 8 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 8 | CAGED | GRASS | KOELERIA MACRANTHA | 2.0 | 20.0 | 17.8 |
| 8 | CAGED | GRASS | POA SPECIES | 2.1 | 21.0 | 18.7 |
| 8 | CAGED | GRASS | STIPA COMATA | 11.7 | 117.0 | 104.1 |
| 9 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.8 | 8.0 | 7.1 |
| 9 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.7 | 7.0 | 6.2 |
| 9 | UNCAGED | FORB | PENSTEMON SPECIES | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.9 | 9.0 | 8.0 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.8 | 8.0 | 7.1 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.1 | 21.0 | 18.7 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.0 | 10.0 | 8.9 |
| 9 | UNCAGED | GRASS | POA SPECIES | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | FORB | COMANDRA UMBELLATA | 21.3 | 213.0 | 189.6 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 5.7 | 57.0 | 50.7 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | IPOMOPSIS AGGREGATA | 2.6 | 26.0 | 23.1 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 36 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 10 | CAGED | FORB | PENSTEMON SPECIES | 0.6 | 6.0 | 5.3 |
| 10 | CAGED | FORB | PHLOX HOODII | 5.8 | 58.0 | 51.6 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 2.8 | 28.0 | 24.9 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 5.7 | 57.0 | 50.7 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | GRASS | POA SPECIES | 1.1 | 11.0 | 9.8 |
| 10 | CAGED | GRASS | STIPA COMATA | 1.0 | 10.0 | 8.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 66.8 | 668.0 | 594.5 |
| GRASSES | 38.4 | 384.0 | 341.8 |
| TOTAL CAGED | 105.2 | 1052 | 936.3 |
| UNCAGED PLOTS | | | |
| FORBS | 149.2 | 1492 | 1328 |
| GRASSES | 26.8 | 268.0 | 238.5 |
| TOTAL UNCAGED | 3184 | 31845 | 28342 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 37 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | | DATA MISSING | . | . | . |
| 2 | UNCAGED | FORB | TOWNSENDIA INCANA | 3.5 | 35.0 | 31.1 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 10.0 | 100.0 | 89.0 |
| 3 | UNCAGED | GRASS | POA SPECIES | 7.7 | 77.0 | 68.5 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.3 | 63.0 | 56.1 |
| 5 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 5 | CAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 5 | CAGED | GRASS | BROMUS TECTORUM | 1.1 | 11.0 | 9.8 |
| 5 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | CRYPTANTHA SERICEA | 0.7 | 7.0 | 6.2 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 6.4 | 64.0 | 57.0 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 1.6 | 16.0 | 14.2 |
| 6 | CAGED | GRASS | POA SPECIES | 6.8 | 68.0 | 60.5 |
| 6 | CAGED | GRASS | STIPA COMATA | 2.9 | 29.0 | 25.8 |
| 7 | CAGED | GRASS | POA SPECIES | 9.1 | 91.0 | 81.0 |
| 7 | CAGED | GRASS | SITANION HYSTRIX | 5.0 | 50.0 | 44.5 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.4 | 24.0 | 21.4 |
| 8 | UNCAGED | GRASS | CAREX SPECIES | 3.4 | 34.0 | 30.3 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.8 | 38.0 | 33.8 |
| 8 | UNCAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | GRASS | SITANION HYSTRIX | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | GRASS | CAREX SPECIES | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | GRASS | POA SPECIES | 5.2 | 52.0 | 46.3 |
| 9 | UNCAGED | GRASS | SITANION HYSTRIX | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 1.0 | 10.0 | 8.9 |
| GRASSES | 33.9 | 339.0 | 301.7 |
| TOTAL CAGED | 34.9 | 349.0 | 310.6 |
| UNCAGED PLOTS | | | |
| FORBS | 3.7 | 37.0 | 32.9 |
| GRASSES | 42.9 | 429.0 | 381.8 |
| TOTAL UNCAGED | 3231 | 32311 | 28757 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 38 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | HAPLOPAPPUS ACAULIS | 4.2 | 42.0 | 37.4 |
| 1 | CAGED | FORB | PHLOX HOODII | 21.7 | 217.0 | 193.1 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 12.9 | 129.0 | 114.8 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 2.3 | 23.0 | 20.5 |
| 1 | CAGED | GRASS | POA SPECIES | 8.2 | 82.0 | 73.0 |
| 2 | UNCAGED | FORB | ASTRAGALUS PURSHII | 2.1 | 21.0 | 18.7 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 0.9 | 9.0 | 8.0 |
| 2 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 6.7 | 67.0 | 59.6 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | GRASS | POA SPECIES | 9.6 | 96.0 | 85.4 |
| 3 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | COMANDRA UMBELLATA | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 1.6 | 16.0 | 14.2 |
| 3 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 3 | UNCAGED | FORB | TOWNSENDIA INCANA | 5.5 | 55.0 | 48.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.3 | 23.0 | 20.5 |
| 3 | UNCAGED | GRASS | POA SPECIES | 8.8 | 88.0 | 78.3 |
| 4 | CAGED | FORB | ASTRAGALUS PURSHII | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | IPOMOPSIS AGGREGATA | 1.0 | 10.0 | 8.9 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 2.4 | 24.0 | 21.4 |
| 4 | CAGED | FORB | UNKNOWN FORB | 0.5 | 5.0 | 4.4 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 1.7 | 17.0 | 15.1 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 7.1 | 71.0 | 63.2 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 4 | CAGED | GRASS | POA SPECIES | 3.4 | 34.0 | 30.3 |
| 5 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.2 | 12.0 | 10.7 |
| 5 | UNCAGED | FORB | ERIGERON EATONII | 2.2 | 22.0 | 19.6 |
| 5 | UNCAGED | FORB | HAPLOPAPPUS ACAULIS | 1.6 | 16.0 | 14.2 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.9 | 19.0 | 16.9 |
| 5 | UNCAGED | GRASS | POA SPECIES | 4.8 | 48.0 | 42.7 |
| 6 | CAGED | FORB | ASTRAGALUS PURSHII | 0.5 | 5.0 | 4.4 |
| 6 | CAGED | FORB | ERIGERON EATONII | 0.2 | 2.0 | 1.8 |
| 6 | CAGED | FORB | PHLOX HOODII | 2.3 | 23.0 | 20.5 |
| 6 | CAGED | FORB | TOWNSENDIA INCANA | 1.6 | 16.0 | 14.2 |
| 6 | CAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 38 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 14.1 | 141.0 | 125.5 |
| 6 | CAGED | GRASS | CAREX SPECIES | 1.2 | 12.0 | 10.7 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 7.9 | 79.0 | 70.3 |
| 6 | CAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 7 | UNCAGED | FORB | ASTRAGALUS SPATULATUS | 0.6 | 6.0 | 5.3 |
| 7 | UNCAGED | FORB | ASTER SPECIES | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.3 | 3.0 | 2.7 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 6.3 | 63.0 | 56.1 |
| 7 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | FORB | TOWNSENDIA INCANA | 10.8 | 108.0 | 96.1 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.4 | 34.0 | 30.3 |
| 7 | UNCAGED | GRASS | POA SPECIES | 2.4 | 24.0 | 21.4 |
| 8 | UNCAGED | FORB | ASTRAGALUS SPATULATUS | 3.1 | 31.0 | 27.6 |
| 8 | UNCAGED | FORB | ASTER SPECIES | 0.6 | 6.0 | 5.3 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS ACAULIS | 1.7 | 17.0 | 15.1 |
| 8 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 12.6 | 126.0 | 112.1 |
| 8 | UNCAGED | FORB | TOWNSENDIA INCANA | 6.2 | 62.0 | 55.2 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.2 | 22.0 | 19.6 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 4.3 | 43.0 | 38.3 |
| 8 | UNCAGED | GRASS | POA SPECIES | 3.5 | 35.0 | 31.1 |
| 9 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.4 | 14.0 | 12.5 |
| 9 | CAGED | FORB | ASTRAGALUS PURSHII | 0.5 | 5.0 | 4.4 |
| 9 | CAGED | FORB | CRUCIFERAE SPECIES | 0.3 | 3.0 | 2.7 |
| 9 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.3 | 3.0 | 2.7 |
| 9 | CAGED | FORB | PHLOX HOODII | 24.1 | 241.0 | 214.5 |
| 9 | CAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 9 | CAGED | FORB | TOWNSENDIA INCANA | 9.3 | 93.0 | 82.8 |
| 9 | CAGED | FORB | UNKNOWN FORB | 6.5 | 65.0 | 57.8 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 3.2 | 32.0 | 28.5 |
| 9 | CAGED | GRASS | KOELERIA MACRANTHA | 5.3 | 53.0 | 47.2 |
| 9 | CAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 9 | CAGED | GRASS | STIPA COMATA | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | FORB | ERIGERON EATONII | 1.6 | 16.0 | 14.2 |
| 10 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.8 | 18.0 | 16.0 |
| 10 | CAGED | FORB | IPOMOPSIS AGGREGATA | 2.0 | 20.0 | 17.8 |
| 10 | CAGED | FORB | KOELERIA MACRANTHA | 2.1 | 21.0 | 18.7 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | SENECIO MULTILOBATUS | 1.0 | 10.0 | 8.9 |
| 10 | CAGED | FORB | TOWNSENDIA INCANA | 2.5 | 25.0 | 22.2 |
| 10 | CAGED | FORB | TRIFOLIUM GYMNOCARPON | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.3 | 3.0 | 2.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 7.4 | 74.0 | 65.9 |
| 10 | CAGED | GRASS | POA SPECIES | 4.5 | 45.0 | 40.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 38 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|
| TRANSECT SUMMARIES | | GRAMS/M2 | KILOGRAMS/HECTARE | | POUNDS/ACRE |
| CAGED PLOTS | | | | | |
| | FORBS | 90.3 | 903.0 | | 803.7 |
| | GRASSES | 81.6 | 816.0 | | 726.2 |
| TOTAL CAGED | | 171.9 | 1719 | | 1530 |
| UNCAGED PLOTS | | | | | |
| | FORBS | 61.8 | 618.0 | | 550.0 |
| | GRASSES | 54.8 | 548.0 | | 487.7 |
| TOTAL UNCAGED | | 3348 | 33477 | | 29795 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 39 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | UNKNOWN FORB | 0.8 | 8.0 | 7.1 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 19.2 | 192.0 | 170.9 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | GRASS | POA SPECIES | 6.6 | 66.0 | 58.7 |
| 1 | CAGED | GRASS | STIPA COMATA | 4.3 | 43.0 | 38.3 |
| 2 | CAGED | FORB | PHLOX HOODII | 3.2 | 32.0 | 28.5 |
| 2 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.3 | 3.0 | 2.7 |
| 2 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 5.2 | 52.0 | 46.3 |
| 2 | CAGED | GRASS | KOELERIA MACRANTHA | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 2 | CAGED | GRASS | STIPA COMATA | 23.7 | 237.0 | 210.9 |
| 3 | UNCAGED | FORB | COMANDRA UMBELLATA | 10.4 | 104.0 | 92.6 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 1.8 | 18.0 | 16.0 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 4.8 | 48.0 | 42.7 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 10.5 | 105.0 | 93.4 |
| 4 | UNCAGED | FORB | UNKNOWN FORB | 3.2 | 32.0 | 28.5 |
| 4 | UNCAGED | GRASS | KOELERIA MACRANTHA | 8.9 | 89.0 | 79.2 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.4 | 24.0 | 21.4 |
| 4 | UNCAGED | GRASS | POA SPECIES | 3.2 | 32.0 | 28.5 |
| 4 | UNCAGED | GRASS | STIPA COMATA | 13.0 | 130.0 | 115.7 |
| 5 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 4.0 | 40.0 | 35.6 |
| 5 | UNCAGED | FORB | COMANDRA UMBELLATA | 3.1 | 31.0 | 27.6 |
| 5 | UNCAGED | FORB | LUPINUS ARGENTEUS | 39.9 | 399.0 | 355.1 |
| 5 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 3.4 | 34.0 | 30.3 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.5 | 15.0 | 13.3 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |
| 5 | UNCAGED | GRASS | STIPA COMATA | 26.3 | 263.0 | 234.1 |
| 6 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 2.0 | 20.0 | 17.8 |
| 6 | UNCAGED | FORB | COMANDRA UMBELLATA | 12.9 | 129.0 | 114.8 |
| 6 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.3 | 3.0 | 2.7 |
| 6 | UNCAGED | FORB | LUPINUS ARGENTEUS | 16.2 | 162.0 | 144.2 |
| 6 | UNCAGED | FORB | UNKNOWN FORB | 1.2 | 12.0 | 10.7 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.3 | 13.0 | 11.6 |
| 7 | CAGED | FORB | COMANDRA UMBELLATA | 8.4 | 84.0 | 74.8 |
| 7 | CAGED | FORB | IPOMOPSIS AGGREGATA | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | LUPINUS ARGENTEUS | 2.6 | 26.0 | 23.1 |
| 7 | CAGED | FORB | UNKNOWN FORB | 1.7 | 17.0 | 15.1 |
| 7 | CAGED | GRASS | KOELERIA MACRANTHA | 1.4 | 14.0 | 12.5 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.3 | 23.0 | 20.5 |
| 7 | CAGED | GRASS | POA SPECIES | 0.7 | 7.0 | 6.2 |
| 7 | CAGED | GRASS | STIPA COMATA | 4.5 | 45.0 | 40.0 |
| 8 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | LUPINUS ARGENTEUS | 0.5 | 5.0 | 4.4 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 39 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.0 | 10.0 | 8.9 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 1.4 | 14.0 | 12.5 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.0 | 30.0 | 26.7 |
| 8 | UNCAGED | GRASS | BROMUS TECTORUM | 9.3 | 93.0 | 82.8 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.4 | 24.0 | 21.4 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 10.2 | 102.0 | 90.8 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 8.1 | 81.0 | 72.1 |
| 9 | CAGED | FORB | COMANDRA UMBELLATA | 5.5 | 55.0 | 48.9 |
| 9 | CAGED | FORB | LINUM LEWISII | 9.9 | 99.0 | 88.1 |
| 9 | CAGED | FORB | LUPINUS ARGENTEUS | 3.3 | 33.0 | 29.4 |
| 9 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | FORB | UNKNOWN FORB | 3.8 | 38.0 | 33.8 |
| 9 | CAGED | GRASS | BROMUS TECTORUM | 19.2 | 192.0 | 170.9 |
| 9 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.0 | 70.0 | 62.3 |
| 9 | CAGED | GRASS | STIPA COMATA | 11.4 | 114.0 | 101.5 |
| 10 | CAGED | | DATA MISSING | • | • | • |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 41.1 | 411.0 | 365.8 |
| GRASSES | 107.8 | 1078 | 959.4 |
| TOTAL CAGED | 148.9 | 1489 | 1325 |
| UNCAGED PLOTS | | | |
| FORBS | 103.7 | 1037 | 922.9 |
| GRASSES | 109.5 | 1095 | 974.5 |
| TOTAL UNCAGED | 3561 | 35609 | 31692 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 40 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ARENARIA FENDLERI | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 2.8 | 28.0 | 24.9 |
| 1 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 4.7 | 47.0 | 41.8 |
| 1 | CAGED | FORB | PHLOX HOODII | 12.9 | 129.0 | 114.8 |
| 1 | CAGED | FORB | SENECIO MULTILOBATUS | 2.7 | 27.0 | 24.0 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.3 | 53.0 | 47.2 |
| 1 | CAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 2 | CAGED | FORB | ARENARIA FENDLERI | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 2 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.3 | 3.0 | 2.7 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 2.6 | 26.0 | 23.1 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 4.5 | 45.0 | 40.0 |
| 2 | CAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 3 | CAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 3 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.7 | 7.0 | 6.2 |
| 3 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 3 | CAGED | GRASS | CAREX SPECIES | 2.0 | 20.0 | 17.8 |
| 4 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 10.5 | 105.0 | 93.4 |
| 4 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 1.7 | 17.0 | 15.1 |
| 4 | UNCAGED | GRASS | CAREX SPECIES | 1.1 | 11.0 | 9.8 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.3 | 13.0 | 11.6 |
| 4 | UNCAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.0 | 20.0 | 17.8 |
| 6 | UNCAGED | GRASS | STIPA COMATA | 0.9 | 9.0 | 8.0 |
| 7 | CAGED | GRASS | POA SPECIES | 2.1 | 21.0 | 18.7 |
| 7 | CAGED | GRASS | STIPA COMATA | 19.7 | 197.0 | 175.3 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.4 | 4.0 | 3.6 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | POA SPECIES | 3.8 | 38.0 | 33.8 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 25.7 | 257.0 | 228.7 |
| GRASSES | 42.4 | 424.0 | 377.4 |
| TOTAL CAGED | 68.1 | 681.0 | 606.1 |
| UNCAGED PLOTS | | | |
| FORBS | 12.4 | 124.0 | 110.4 |
| GRASSES | 5.8 | 58.0 | 51.6 |
| TOTAL UNCAGED | 3579 | 35791 | 31854 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 41 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 7.2 | 72.0 | 64.1 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 3.5 | 35.0 | 31.1 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 13.5 | 135.0 | 120.1 |
| 1 | CAGED | GRASS | POA SPECIES | 2.9 | 29.0 | 25.8 |
| 1 | CAGED | GRASS | STIPA COMATA | 15.7 | 157.0 | 139.7 |
| 2 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 2.1 | 21.0 | 18.7 |
| 2 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 4.8 | 48.0 | 42.7 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.8 | 28.0 | 24.9 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.5 | 15.0 | 13.3 |
| 2 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | GRASS | STIPA COMATA | 18.8 | 188.0 | 167.3 |
| 3 | CAGED | FORB | CRYPTANTHA SERICEA | 1.4 | 14.0 | 12.5 |
| 3 | CAGED | FORB | PHLOX HOODII | 3.1 | 31.0 | 27.6 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 3.3 | 33.0 | 29.4 |
| 3 | CAGED | GRASS | KOELERIA MACRANTHA | 1.3 | 13.0 | 11.6 |
| 3 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 7.2 | 72.0 | 64.1 |
| 3 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | CAGED | GRASS | STIPA COMATA | 16.4 | 164.0 | 146.0 |
| 4 | CAGED | FORB | PHLOX HOODII | 18.0 | 180.0 | 160.2 |
| 4 | CAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 6.1 | 61.0 | 54.3 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 5.4 | 54.0 | 48.1 |
| 4 | CAGED | GRASS | POA SPECIES | 2.3 | 23.0 | 20.5 |
| 4 | CAGED | GRASS | STIPA COMATA | 18.5 | 185.0 | 164.6 |
| 5 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 0.4 | 4.0 | 3.6 |
| 5 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.8 | 8.0 | 7.1 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.6 | 26.0 | 23.1 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.7 | 17.0 | 15.1 |
| 5 | UNCAGED | GRASS | POA SPECIES | 2.2 | 22.0 | 19.6 |
| 5 | UNCAGED | GRASS | STIPA COMATA | 29.8 | 298.0 | 265.2 |
| 6 | CAGED | FORB | CRUCIFERAE SPECIES | 1.4 | 14.0 | 12.5 |
| 6 | CAGED | GRASS | KOELERIA MACRANTHA | 0.3 | 3.0 | 2.7 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.8 | 68.0 | 60.5 |
| 6 | CAGED | GRASS | STIPA COMATA | 5.5 | 55.0 | 48.9 |
| 7 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.2 | 2.0 | 1.8 |
| 7 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 16.5 | 165.0 | 146.8 |
| 7 | UNCAGED | FORB | POA SPECIES | 1.6 | 16.0 | 14.2 |
| 7 | UNCAGED | FORB | UNKNOWN FORB | 4.5 | 45.0 | 40.0 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 41 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 7 | UNCAGED | GRASS | STIPA COMATA | 27.0 | 270.0 | 240.3 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 2.0 | 20.0 | 17.8 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 7.9 | 79.0 | 70.3 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 1.1 | 11.0 | 9.8 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 5.1 | 51.0 | 45.4 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 6.2 | 62.0 | 55.2 |
| 8 | UNCAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 9.2 | 92.0 | 81.9 |
| 9 | UNCAGED | FORB | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 12.5 | 125.0 | 111.2 |
| 9 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.7 | 7.0 | 6.2 |
| 9 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.6 | 16.0 | 14.2 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.3 | 33.0 | 29.4 |
| 9 | UNCAGED | GRASS | POA SPECIES | 0.6 | 6.0 | 5.3 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 13.8 | 138.0 | 122.8 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.3 | 13.0 | 11.6 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 2.1 | 21.0 | 18.7 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 1.8 | 18.0 | 16.0 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | POA SPECIES | 1.5 | 15.0 | 13.3 |
| 10 | CAGED | GRASS | STIPA COMATA | 21.8 | 218.0 | 194.0 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 25.5 | 255.0 | 226.9 |
| GRASSES | 143.3 | 1433 | 1275 |
| TOTAL CAGED | 168.8 | 1688 | 1502 |
| UNCAGED PLOTS | | | |
| FORBS | 51.9 | 519.0 | 461.9 |
| GRASSES | 134.5 | 1345 | 1197 |
| TOTAL UNCAGED | 3765 | 37655 | 33513 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 42 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CHAMAESYCE FENDLERI | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.7 | 7.0 | 6.2 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 1.2 | 12.0 | 10.7 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 4.1 | 41.0 | 36.5 |
| 2 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.3 | 3.0 | 2.7 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.8 | 18.0 | 16.0 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.4 | 24.0 | 21.4 |
| 2 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | ASTER SPECIES | 0.4 | 4.0 | 3.6 |
| 3 | UNCAGED | FORB | CHAMAESYCE FENDLERI | 0.8 | 8.0 | 7.1 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.9 | 19.0 | 16.9 |
| 3 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 7.5 | 75.0 | 66.7 |
| 3 | UNCAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.6 | 6.0 | 5.3 |
| 3 | UNCAGED | FORB | SENECIO MULTILOBATUS | 1.4 | 14.0 | 12.5 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 2.1 | 21.0 | 18.7 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 6.3 | 63.0 | 56.1 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 9.3 | 93.0 | 82.8 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 4.6 | 46.0 | 40.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | POA SPECIES | 1.2 | 12.0 | 10.7 |
| 6 | CAGED | FORB | HAPLOPAPPUS ACAULIS | 1.2 | 12.0 | 10.7 |
| 6 | CAGED | FORB | PHLOX HOODII | 4.5 | 45.0 | 40.0 |
| 6 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.0 | 10.0 | 8.9 |
| 6 | CAGED | GRASS | POA SPECIES | 2.6 | 26.0 | 23.1 |
| 7 | UNCAGED | FORB | CHAMAESYCE FENDLERI | 0.3 | 3.0 | 2.7 |
| 8 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 9 | CAGED | FORB | CHAMAESYCE FENDLERI | 2.6 | 26.0 | 23.1 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 0.7 | 7.0 | 6.2 |
| 9 | CAGED | GRASS | AGROPYRON SPECIES | 0.6 | 6.0 | 5.3 |
| 10 | CAGED | | NO VEGETATION | • | • | • |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 11.6 | 116.0 | 103.2 |
| GRASSES | 8.3 | 83.0 | 73.9 |
| TOTAL CAGED | 19.9 | 199.0 | 177.1 |
| UNCAGED PLOTS | | | |
| FORBS | 26.1 | 261.0 | 232.3 |
| GRASSES | 18.5 | 185.0 | 164.6 |
| TOTAL UNCAGED | 3810 | 38101 | 33910 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 43 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 0.7 | 7.0 | 6.2 |
| 1 | CAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | MACHAERANTHERA PATTERSONII | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | GRASS | POA SPECIES | 13.7 | 137.0 | 121.9 |
| 1 | CAGED | GRASS | SITANION HYSTRIX | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | GRASS | STIPA COMATA | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.4 | 14.0 | 12.5 |
| 2 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.2 | 2.0 | 1.8 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 2.0 | 20.0 | 17.8 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.6 | 16.0 | 14.2 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.8 | 38.0 | 33.8 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 0.6 | 6.0 | 5.3 |
| 4 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.7 | 17.0 | 15.1 |
| 4 | CAGED | FORB | PHLOX HOODII | 27.9 | 279.0 | 248.3 |
| 4 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | TOWNSENDIA INCANA | 2.1 | 21.0 | 18.7 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.2 | 32.0 | 28.5 |
| 4 | CAGED | GRASS | POA SPECIES | 1.5 | 15.0 | 13.3 |
| 5 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 11.7 | 117.0 | 104.1 |
| 5 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 5 | UNCAGED | GRASS | POA SPECIES | 4.4 | 44.0 | 39.2 |
| 6 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | PHLOX HOODII | 15.4 | 154.0 | 137.1 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 3.4 | 34.0 | 30.3 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | LAPPULA REDOWSKII | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | CAGED | FORB | PHLOX HOODII | 1.7 | 17.0 | 15.1 |
| 8 | CAGED | FORB | SENECIO MULTILOBATUS | 0.6 | 6.0 | 5.3 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |
| 9 | UNCAGED | FORB | ASTRAGALUS PURSHII | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | CHENOPODIUM SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 5.2 | 52.0 | 46.3 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 9 | UNCAGED | GRASS | POA SPECIES | 3.1 | 31.0 | 27.6 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 2.7 | 27.0 | 24.0 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 43 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 10 | CAGED | FORB | PHLOX HOODII | 3.0 | 30.0 | 26.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.1 | 21.0 | 18.7 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 56.4 | 564.0 | 502.0 |
| GRASSES | 31.3 | 313.0 | 278.6 |
| TOTAL CAGED | 87.7 | 877.0 | 780.5 |
| UNCAGED PLOTS | | | |
| FORBS | 19.4 | 194.0 | 172.7 |
| GRASSES | 20.0 | 200.0 | 178.0 |
| TOTAL UNCAGED | 3849 | 38495 | 34261 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 44 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 6.5 | 65.0 | 57.8 |
| 1 | CAGED | FORB | IPOMOPSIS AGGREGATA | 6.8 | 68.0 | 60.5 |
| 1 | CAGED | FORB | PHLOX HOODII | 6.4 | 64.0 | 57.0 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 1 | CAGED | GRASS | CAREX SPECIES | 3.2 | 32.0 | 28.5 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | GRASS | POA SPECIES | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | STIPA COMATA | 9.6 | 96.0 | 85.4 |
| 2 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 4.6 | 46.0 | 40.9 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 12.0 | 120.0 | 106.8 |
| 2 | UNCAGED | FORB | UNKNOWN FORB | 0.3 | 3.0 | 2.7 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.0 | 10.0 | 8.9 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 1.4 | 14.0 | 12.5 |
| 2 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.4 | 54.0 | 48.1 |
| 2 | UNCAGED | GRASS | STIPA COMATA | 10.3 | 103.0 | 91.7 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.1 | 51.0 | 45.4 |
| 3 | UNCAGED | GRASS | CAREX SPECIES | 0.9 | 9.0 | 8.0 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.7 | 7.0 | 6.2 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.2 | 32.0 | 28.5 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 14.8 | 148.0 | 131.7 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 13.1 | 131.0 | 116.6 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.3 | 13.0 | 11.6 |
| 4 | UNCAGED | GRASS | CAREX SPECIES | 1.4 | 14.0 | 12.5 |
| 4 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 9.1 | 91.0 | 81.0 |
| 4 | UNCAGED | GRASS | SITANION HYSTRIX | 0.4 | 4.0 | 3.6 |
| 4 | UNCAGED | GRASS | STIPA COMATA | 5.2 | 52.0 | 46.3 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 15.1 | 151.0 | 134.4 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 4.1 | 41.0 | 36.5 |
| 5 | UNCAGED | GRASS | CAREX SPECIES | 1.3 | 13.0 | 11.6 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.9 | 9.0 | 8.0 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.3 | 3.0 | 2.7 |
| 5 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | STIPA COMATA | 5.5 | 55.0 | 48.9 |
| 6 | CAGED | FORB | PHLOX HOODII | 8.6 | 86.0 | 76.5 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 1.8 | 18.0 | 16.0 |
| 6 | CAGED | GRASS | CAREX SPECIES | 2.8 | 28.0 | 24.9 |
| 6 | CAGED | GRASS | POA SPECIES | 1.7 | 17.0 | 15.1 |
| 6 | CAGED | GRASS | STIPA COMATA | 14.8 | 148.0 | 131.7 |
| 7 | CAGED | FORB | PHLOX HOODII | 11.9 | 119.0 | 105.9 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 4.6 | 46.0 | 40.9 |
| 7 | CAGED | GRASS | CAREX SPECIES | 1.1 | 11.0 | 9.8 |
| 7 | CAGED | GRASS | KOELERIA MACRANTHA | 0.8 | 8.0 | 7.1 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.3 | 3.0 | 2.7 |
| 7 | CAGED | GRASS | STIPA COMATA | 9.3 | 93.0 | 82.8 |
| 8 | CAGED | FORB | PHLOX HOODII | 3.5 | 35.0 | 31.1 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 8 | CAGED | GRASS | CAREX SPECIES | 2.3 | 23.0 | 20.5 |
| 8 | CAGED | GRASS | KOELERIA MACRANTHA | 1.5 | 15.0 | 13.3 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.4 | 34.0 | 30.3 |
| 8 | CAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 44 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | CAGED | GRASS | STIPA COMATA | 6.8 | 68.0 | 60.5 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 20.7 | 207.0 | 184.2 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 5.3 | 53.0 | 47.2 |
| 9 | UNCAGED | GRASS | CAREX SPECIES | 1.8 | 18.0 | 16.0 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.3 | 3.0 | 2.7 |
| 9 | UNCAGED | GRASS | POA SPECIES | 1.3 | 13.0 | 11.6 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 6.4 | 64.0 | 57.0 |
| 10 | CAGED | FORB | PHLOX HOODII | 5.8 | 58.0 | 51.6 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 10.8 | 108.0 | 96.1 |
| 10 | CAGED | GRASS | CAREX SPECIES | 1.8 | 18.0 | 16.0 |
| 10 | CAGED | GRASS | STIPA COMATA | 9.2 | 92.0 | 81.9 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 49.5 | 495.0 | 440.5 |
| GRASSES | 90.8 | 908.0 | 808.1 |
| TOTAL CAGED | 140.3 | 1403 | 1249 |
| UNCAGED PLOTS | | | |
| FORBS | 65.8 | 658.0 | 585.6 |
| GRASSES | 87.5 | 875.0 | 778.7 |
| TOTAL UNCAGED | 4003 | 40028 | 35625 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 45 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | PHLOX HOODII | 20.4 | 204.0 | 181.6 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | FORB | TOWNSENDIA INCANA | 1.8 | 18.0 | 16.0 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 10.3 | 103.0 | 91.7 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 1.4 | 14.0 | 12.5 |
| 1 | CAGED | GRASS | POA SPECIES | 8.6 | 86.0 | 76.5 |
| 1 | CAGED | GRASS | STIPA COMATA | 15.1 | 151.0 | 134.4 |
| 2 | CAGED | FORB | PHLOX HOODII | 12.4 | 124.0 | 110.4 |
| 2 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.4 | 4.0 | 3.6 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 8.7 | 87.0 | 77.4 |
| 2 | CAGED | GRASS | KOELERIA MACRANTHA | 3.1 | 31.0 | 27.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.1 | 11.0 | 9.8 |
| 2 | CAGED | GRASS | POA SPECIES | 2.9 | 29.0 | 25.8 |
| 3 | CAGED | FORB | PHLOX HOODII | 25.4 | 254.0 | 226.1 |
| 3 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.8 | 8.0 | 7.1 |
| 3 | CAGED | FORB | UNKNOWN FORB | 2.1 | 21.0 | 18.7 |
| 3 | CAGED | GRASS | AGROPYRON SPECIES | 7.7 | 77.0 | 68.5 |
| 3 | CAGED | GRASS | KOELERIA MACRANTHA | 10.6 | 106.0 | 94.3 |
| 3 | CAGED | GRASS | POA SPECIES | 2.5 | 25.0 | 22.2 |
| 3 | CAGED | GRASS | STIPA COMATA | 8.7 | 87.0 | 77.4 |
| 4 | UNCAGED | FORB | KOELERIA MACRANTHA | 0.6 | 6.0 | 5.3 |
| 4 | UNCAGED | FORB | PHLOX HOODII | 28.8 | 288.0 | 256.3 |
| 4 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.1 | 11.0 | 9.8 |
| 4 | UNCAGED | FORB | UNKNOWN FORB | 0.7 | 7.0 | 6.2 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.7 | 27.0 | 24.0 |
| 4 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | UNCAGED | GRASS | STIPA COMATA | 4.2 | 42.0 | 37.4 |
| 5 | CAGED | FORB | PHLOX HOODII | 11.8 | 118.0 | 105.0 |
| 5 | CAGED | FORB | SPHAERALCEA COCCINEA | 2.7 | 27.0 | 24.0 |
| 5 | CAGED | FORB | UNKNOWN FORB | 0.5 | 5.0 | 4.4 |
| 5 | CAGED | GRASS | AGROPYRON SPECIES | 6.9 | 69.0 | 61.4 |
| 5 | CAGED | GRASS | KOELERIA MACRANTHA | 5.9 | 59.0 | 52.5 |
| 5 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.4 | 4.0 | 3.6 |
| 5 | CAGED | GRASS | POA SPECIES | 1.9 | 19.0 | 16.9 |
| 5 | CAGED | GRASS | STIPA COMATA | 21.4 | 214.0 | 190.5 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 27.7 | 277.0 | 246.5 |
| 6 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 2.4 | 24.0 | 21.4 |
| 6 | UNCAGED | FORB | UNKNOWN FORB | 1.3 | 13.0 | 11.6 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.4 | 4.0 | 3.6 |
| 6 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.7 | 17.0 | 15.1 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | GRASS | POA SPECIES | 4.2 | 42.0 | 37.4 |
| 6 | UNCAGED | GRASS | STIPA COMATA | 17.9 | 179.0 | 159.3 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 21.4 | 214.0 | 190.5 |
| 7 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 3.7 | 37.0 | 32.9 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 13.1 | 131.0 | 116.6 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.1 | 11.0 | 9.8 |
| 7 | UNCAGED | GRASS | POA SPECIES | 0.6 | 6.0 | 5.3 |
| 7 | UNCAGED | GRASS | STIPA COMATA | 24.9 | 249.0 | 221.6 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 45 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 8 | UNCAGED | FORB | PHLOX HOODII | 7.5 | 75.0 | 66.7 |
| 8 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | UNKNOWN FORB | 0.7 | 7.0 | 6.2 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.9 | 39.0 | 34.7 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.1 | 31.0 | 27.6 |
| 8 | UNCAGED | GRASS | POA SPECIES | 4.4 | 44.0 | 39.2 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 23.8 | 238.0 | 211.8 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 13.4 | 134.0 | 119.3 |
| 9 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.5 | 15.0 | 13.3 |
| 9 | UNCAGED | FORB | UNKNOWN FORB | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 7.2 | 72.0 | 64.1 |
| 9 | UNCAGED | GRASS | CAREX SPECIES | 2.5 | 25.0 | 22.2 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 2.4 | 24.0 | 21.4 |
| 9 | UNCAGED | GRASS | POA SPECIES | 2.2 | 22.0 | 19.6 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 6.9 | 69.0 | 61.4 |
| 10 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.1 | 11.0 | 9.8 |
| 10 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | FORB | PHLOX HOODII | 122.1 | 1221 | 1087 |
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 10 | CAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 6.5 | 65.0 | 57.8 |
| 10 | CAGED | GRASS | POA SPECIES | 0.8 | 8.0 | 7.1 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 203.9 | 2039 | 1815 |
| GRASSES | 126.1 | 1261 | 1122 |
| TOTAL CAGED | 330.0 | 3300 | 2937 |
| UNCAGED PLOTS | | | |
| FORBS | 112.2 | 1122 | 998.6 |
| GRASSES | 127.4 | 1274 | 1134 |
| TOTAL UNCAGED | 4242 | 42424 | 37757 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 46 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 5.3 | 53.0 | 47.2 |
| 1 | CAGED | GRASS | POA SPECIES | 0.6 | 6.0 | 5.3 |
| 2 | CAGED | FORB | PHLOX HOODII | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | FORB | SENECIO MULTILOBATUS | 2.9 | 29.0 | 25.8 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 4.8 | 48.0 | 42.7 |
| 2 | CAGED | GRASS | POA SPECIES | 8.1 | 81.0 | 72.1 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 29.5 | 295.0 | 262.5 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 3 | UNCAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 5.5 | 55.0 | 48.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 6.3 | 63.0 | 56.1 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.9 | 29.0 | 25.8 |
| 5 | UNCAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | CRYPTANTHA SERICEA | 1.9 | 19.0 | 16.9 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.8 | 8.0 | 7.1 |
| 6 | CAGED | GRASS | STIPA COMATA | 2.3 | 23.0 | 20.5 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.3 | 23.0 | 20.5 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 18.4 | 184.0 | 163.8 |
| 7 | UNCAGED | GRASS | POA SPECIES | 0.3 | 3.0 | 2.7 |
| 7 | UNCAGED | GRASS | STIPA COMATA | 8.7 | 87.0 | 77.4 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 2.3 | 23.0 | 20.5 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.5 | 15.0 | 13.3 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 23.3 | 233.0 | 207.4 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 4.9 | 49.0 | 43.6 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 2.8 | 28.0 | 24.9 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.2 | 12.0 | 10.7 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.8 | 38.0 | 33.8 |
| 9 | UNCAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | PHLOX HOODII | 45.1 | 451.0 | 401.4 |
| 10 | CAGED | FORB | PHYSARIA FLORIBUNDA | 3.7 | 37.0 | 32.9 |
| 10 | CAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 3.8 | 38.0 | 33.8 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | GRASS | POA SPECIES | 6.7 | 67.0 | 59.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 54.1 | 541.0 | 481.5 |
| GRASSES | 41.5 | 415.0 | 369.3 |
| TOTAL CAGED | 95.6 | 956.0 | 850.8 |
| UNCAGED PLOTS | | | |
| FORBS | 35.1 | 351.0 | 312.4 |
| GRASSES | 76.2 | 762.0 | 678.2 |
| TOTAL UNCAGED | 4354 | 43537 | 38748 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 47 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | FORB | CRYPTANTHA SERICEA | 1.9 | 19.0 | 16.9 |
| 1 | CAGED | FORB | HEDYSARUM BOREALE | 5.9 | 59.0 | 52.5 |
| 1 | CAGED | FORB | PHLOX HOODII | 5.1 | 51.0 | 45.4 |
| 1 | CAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 1 | CAGED | FORB | UNKNOWN FORB | 0.8 | 8.0 | 7.1 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 1 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 3.2 | 32.0 | 28.5 |
| 1 | CAGED | GRASS | POA SPECIES | 1.9 | 19.0 | 16.9 |
| 1 | CAGED | GRASS | STIPA COMATA | 16.5 | 165.0 | 146.8 |
| 2 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 8.8 | 88.0 | 78.3 |
| 2 | CAGED | FORB | HEDYSARUM BOREALE | 0.6 | 6.0 | 5.3 |
| 2 | CAGED | FORB | PHLOX HOODII | 19.4 | 194.0 | 172.7 |
| 2 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.5 | 5.0 | 4.4 |
| 2 | CAGED | FORB | UNKNOWN FORB | 1.1 | 11.0 | 9.8 |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 2.7 | 27.0 | 24.0 |
| 2 | CAGED | GRASS | KOELERIA MACRANTHA | 12.2 | 122.0 | 108.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.7 | 7.0 | 6.2 |
| 2 | CAGED | GRASS | POA SPECIES | 6.0 | 60.0 | 53.4 |
| 2 | CAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | GRASS | STIPA COMATA | 2.2 | 22.0 | 19.6 |
| 3 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | HEDYSARUM BOREALE | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 15.7 | 157.0 | 139.7 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 6.8 | 68.0 | 60.5 |
| 3 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.7 | 17.0 | 15.1 |
| 3 | UNCAGED | GRASS | POA SPECIES | 5.1 | 51.0 | 45.4 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 2.7 | 27.0 | 24.0 |
| 4 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.4 | 4.0 | 3.6 |
| 4 | CAGED | FORB | HEDYSARUM BOREALE | 4.8 | 48.0 | 42.7 |
| 4 | CAGED | FORB | PHLOX HOODII | 0.8 | 8.0 | 7.1 |
| 4 | CAGED | FORB | UNKNOWN FORB | 0.3 | 3.0 | 2.7 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 1.1 | 11.0 | 9.8 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 2.6 | 26.0 | 23.1 |
| 4 | CAGED | GRASS | POA SPECIES | 6.9 | 69.0 | 61.4 |
| 4 | CAGED | GRASS | STIPA COMATA | 20.4 | 204.0 | 181.6 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | FORB | HEDYSARUM BOREALE | 9.4 | 94.0 | 83.7 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 11.2 | 112.0 | 99.7 |
| 5 | UNCAGED | FORB | UNKNOWN FORB | 2.0 | 20.0 | 17.8 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 16.4 | 164.0 | 146.0 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.2 | 12.0 | 10.7 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 47 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 5 | UNCAGED | GRASS | POA SPECIES | 0.5 | 5.0 | 4.4 |
| 5 | UNCAGED | GRASS | STIPA COMATA | 14.0 | 140.0 | 124.6 |
| 6 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | PHLOX HOODII | 0.3 | 3.0 | 2.7 |
| 6 | CAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | FORB | PHYSARIA FLORIBUNDA | 0.5 | 5.0 | 4.4 |
| 6 | CAGED | FORB | UNKNOWN FORB | 0.2 | 2.0 | 1.8 |
| 6 | CAGED | GRASS | AGROPYRON SPECIES | 10.7 | 107.0 | 95.2 |
| 6 | CAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 6 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 3.1 | 31.0 | 27.6 |
| 6 | CAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 6 | CAGED | GRASS | STIPA COMATA | 16.1 | 161.0 | 143.3 |
| 7 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 4.4 | 44.0 | 39.2 |
| 7 | UNCAGED | FORB | HEDYSARUM BOREALE | 4.0 | 40.0 | 35.6 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 1.6 | 16.0 | 14.2 |
| 7 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.3 | 3.0 | 2.7 |
| 7 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.9 | 9.0 | 8.0 |
| 7 | UNCAGED | FORB | UNKNOWN FORB | 0.3 | 3.0 | 2.7 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 3.5 | 35.0 | 31.1 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 3.6 | 36.0 | 32.0 |
| 7 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.5 | 5.0 | 4.4 |
| 7 | UNCAGED | GRASS | POA SPECIES | 3.7 | 37.0 | 32.9 |
| 7 | UNCAGED | GRASS | STIPA COMATA | 8.8 | 88.0 | 78.3 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.2 | 2.0 | 1.8 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 10.6 | 106.0 | 94.3 |
| 8 | UNCAGED | FORB | PENSTEMON SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | PHLOX HOODII | 10.1 | 101.0 | 89.9 |
| 8 | UNCAGED | FORB | SENECIO MULTILOBATUS | 4.9 | 49.0 | 43.6 |
| 8 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | GRASS | KOELERIA MACRANTHA | 14.6 | 146.0 | 129.9 |
| 8 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.6 | 16.0 | 14.2 |
| 8 | UNCAGED | GRASS | POA SPECIES | 1.3 | 13.0 | 11.6 |
| 8 | UNCAGED | GRASS | STIPA COMATA | 3.5 | 35.0 | 31.1 |
| 9 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 1.4 | 14.0 | 12.5 |
| 9 | UNCAGED | FORB | ASTER SPECIES | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.8 | 18.0 | 16.0 |
| 9 | UNCAGED | FORB | PHLOX HOODII | 1.4 | 14.0 | 12.5 |
| 9 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 2.1 | 21.0 | 18.7 |
| 9 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.8 | 8.0 | 7.1 |
| 9 | UNCAGED | FORB | UNKNOWN FORB | 1.6 | 16.0 | 14.2 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.7 | 27.0 | 24.0 |
| 9 | UNCAGED | GRASS | BROMUS TECTORUM | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 13.4 | 134.0 | 119.3 |
| 9 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 5.5 | 55.0 | 48.9 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 5.9 | 59.0 | 52.5 |
| 10 | CAGED | FORB | CREPIS OCCIDENTALIS | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | CRYPTANTHA SERICEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | HEDYSARUM BOREALE | 7.4 | 74.0 | 65.9 |
| 10 | CAGED | FORB | PHLOX HOODII | 0.4 | 4.0 | 3.6 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 47 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | FORB | UNKNOWN FORB | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 2.1 | 21.0 | 18.7 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 2.6 | 26.0 | 23.1 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 10.3 | 103.0 | 91.7 |
| 10 | CAGED | GRASS | POA SPECIES | 2.2 | 22.0 | 19.6 |
| 10 | CAGED | GRASS | STIPA COMATA | 4.9 | 49.0 | 43.6 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 62.0 | 620.0 | 551.8 |
| GRASSES | 129.5 | 1295 | 1153 |
| TOTAL CAGED | 191.5 | 1915 | 1704 |
| UNCAGED PLOTS | | | |
| FORBS | 86.5 | 865.0 | 769.8 |
| GRASSES | 117.3 | 1173 | 1044 |
| TOTAL UNCAGED | 4557 | 45575 | 40562 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 48 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | | DATA MISSING | . | . | . |
| 2 | CAGED | GRASS | AGROPYRON SPECIES | 4.0 | 40.0 | 35.6 |
| 2 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 2 | CAGED | GRASS | POA SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | GRASS | POA SPECIES | 10.8 | 108.0 | 96.1 |
| 4 | CAGED | FORB | PHLOX HOODII | 1.9 | 19.0 | 16.9 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 5.9 | 59.0 | 52.5 |
| 4 | CAGED | GRASS | CAREX SPECIES | 7.0 | 70.0 | 62.3 |
| 5 | CAGED | GRASS | POA SPECIES | 0.8 | 8.0 | 7.1 |
| 6 | UNCAGED | GRASS | CAREX SPECIES | 1.3 | 13.0 | 11.6 |
| 6 | UNCAGED | GRASS | POA SPECIES | 0.4 | 4.0 | 3.6 |
| 6 | UNCAGED | GRASS | SITANION HYSTRIX | 0.6 | 6.0 | 5.3 |
| 7 | UNCAGED | FORB | CRYPTANTHA SERICEA | 7.8 | 78.0 | 69.4 |
| 7 | UNCAGED | FORB | PHYSARIA FLORIBUNDA | 0.8 | 8.0 | 7.1 |
| 7 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 7 | UNCAGED | GRASS | CAREX SPECIES | 1.1 | 11.0 | 9.8 |
| 7 | UNCAGED | GRASS | KOELERIA MACRANTHA | 1.0 | 10.0 | 8.9 |
| 7 | UNCAGED | GRASS | POA SPECIES | 1.9 | 19.0 | 16.9 |
| 8 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.1 | 1.0 | 0.9 |
| 8 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.3 | 3.0 | 2.7 |
| 8 | UNCAGED | GRASS | CAREX SPECIES | 2.8 | 28.0 | 24.9 |
| 8 | UNCAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 8 | UNCAGED | GRASS | SITANION HYSTRIX | 0.6 | 6.0 | 5.3 |
| 9 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | UNCAGED | GRASS | CAREX SPECIES | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | GRASS | POA SPECIES | 10.3 | 103.0 | 91.7 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 2.3 | 23.0 | 20.5 |
| 10 | CAGED | GRASS | CAREX SPECIES | 2.5 | 25.0 | 22.2 |
| 10 | CAGED | GRASS | POA SPECIES | 18.6 | 186.0 | 165.5 |
| 10 | CAGED | GRASS | SITANION HYSTRIX | 3.5 | 35.0 | 31.1 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 1.9 | 19.0 | 16.9 |
| GRASSES | 42.6 | 426.0 | 379.1 |
| TOTAL CAGED | 44.5 | 445.0 | 396.0 |
| UNCAGED PLOTS | | | |
| FORBS | 9.2 | 92.0 | 81.9 |
| GRASSES | 37.6 | 376.0 | 334.6 |
| TOTAL UNCAGED | 4604 | 46043 | 40978 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 49 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | FORB | HAPLOPAPPUS NUTTALLII | 2.3 | 23.0 | 20.5 |
| 1 | CAGED | FORB | LUPINUS ARGENTEUS | 0.3 | 3.0 | 2.7 |
| 1 | CAGED | FORB | PHLOX HOODII | 6.1 | 61.0 | 54.3 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 2.1 | 21.0 | 18.7 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 1.1 | 11.0 | 9.8 |
| 1 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 1 | CAGED | GRASS | POA SPECIES | 7.3 | 73.0 | 65.0 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 17.2 | 172.0 | 153.1 |
| 2 | UNCAGED | FORB | ERIGERON EATONII | 0.4 | 4.0 | 3.6 |
| 2 | UNCAGED | FORB | LINUM LEWISII | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | LUPINUS ARGENTEUS | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | GRASS | POA SPECIES | 22.4 | 224.0 | 199.4 |
| 2 | UNCAGED | GRASS | SITANION HYSTRIX | 0.2 | 2.0 | 1.8 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 0.8 | 8.0 | 7.1 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | IPOMOPSIS AGGREGATA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.3 | 3.0 | 2.7 |
| 3 | UNCAGED | FORB | TOWNSENDIA INCANA | 3.2 | 32.0 | 28.5 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | GRASS | POA SPECIES | 20.0 | 200.0 | 178.0 |
| 4 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 1.3 | 13.0 | 11.6 |
| 4 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.8 | 8.0 | 7.1 |
| 4 | UNCAGED | GRASS | POA SPECIES | 0.7 | 7.0 | 6.2 |
| 5 | UNCAGED | FORB | HAPLOPAPPUS NUTTALLII | 0.4 | 4.0 | 3.6 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.9 | 9.0 | 8.0 |
| 6 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | FORB | CRYPTANTHA SERICEA | 3.5 | 35.0 | 31.1 |
| 6 | UNCAGED | FORB | PHLOX HOODII | 1.3 | 13.0 | 11.6 |
| 6 | UNCAGED | FORB | SENECIO MULTILOBATUS | 0.1 | 1.0 | 0.9 |
| 6 | UNCAGED | GRASS | AGROPYRON SPECIES | 1.9 | 19.0 | 16.9 |
| 6 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 8.8 | 88.0 | 78.3 |
| 6 | UNCAGED | GRASS | POA SPECIES | 4.3 | 43.0 | 38.3 |
| 7 | CAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | CRYPTANTHA SERICEA | 4.1 | 41.0 | 36.5 |
| 7 | CAGED | FORB | LUPINUS ARGENTEUS | 0.1 | 1.0 | 0.9 |
| 7 | CAGED | FORB | SENECIO MULTILOBATUS | 0.2 | 2.0 | 1.8 |
| 7 | CAGED | GRASS | AGROPYRON SPECIES | 3.0 | 30.0 | 26.7 |
| 7 | CAGED | GRASS | CAREX SPECIES | 1.2 | 12.0 | 10.7 |
| 7 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 1.0 | 10.0 | 8.9 |
| 7 | CAGED | GRASS | POA SPECIES | 3.7 | 37.0 | 32.9 |
| 7 | CAGED | GRASS | STIPA COMATA | 3.3 | 33.0 | 29.4 |
| 8 | CAGED | FORB | CRYPTANTHA SERICEA | 5.6 | 56.0 | 49.8 |
| 8 | CAGED | FORB | LUPINUS ARGENTEUS | 1.1 | 11.0 | 9.8 |
| 8 | CAGED | FORB | PHLOX HOODII | 5.0 | 50.0 | 44.5 |
| 8 | CAGED | GRASS | AGROPYRON SPECIES | 2.7 | 27.0 | 24.0 |
| 8 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 12.4 | 124.0 | 110.4 |
| 9 | CAGED | FORB | CREPIS OCCIDENTALIS | 0.3 | 3.0 | 2.7 |
| 9 | CAGED | FORB | CRYPTANTHA SERICEA | 9.2 | 92.0 | 81.9 |
| 9 | CAGED | FORB | PHLOX HOODII | 15.6 | 156.0 | 138.8 |

APPENDIX . RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 49 VEGETATION TYPE= PINYON JUNIPER
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 9 | CAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 9 | CAGED | GRASS | POA SPECIES | 8.8 | 88.0 | 78.3 |
| 10 | CAGED | FORB | LUPINUS SPECIES | 0.7 | 7.0 | 6.2 |
| 10 | CAGED | FORB | PHLOX HOODII | 10.3 | 103.0 | 91.7 |
| 10 | CAGED | GRASS | AGROPYRON SPECIES | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | GRASS | ORYZOPSIS HYMENOIDES | 0.2 | 2.0 | 1.8 |
| 10 | CAGED | GRASS | POA SPECIES | 7.2 | 72.0 | 64.1 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 61.1 | 611.0 | 543.8 |
| GRASSES | 55.2 | 552.0 | 491.3 |
| TOTAL CAGED | 116.3 | 1163 | 1035 |
| UNCAGED PLOTS | | | |
| FORBS | 29.0 | 290.0 | 258.1 |
| GRASSES | 60.1 | 601.0 | 534.9 |
| TOTAL UNCAGED | 4693 | 46934 | 41771 |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 50 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 1 | CAGED | FORB | CREPIS OCCIDENTALIS | 3.0 | 30.0 | 26.7 |
| 1 | CAGED | FORB | ERIGERON EATONII | 2.0 | 20.0 | 17.8 |
| 1 | CAGED | FORB | PENSTEMON SPECIES | 1.5 | 15.0 | 13.3 |
| 1 | CAGED | FORB | PHLOX HOODII | 0.4 | 4.0 | 3.6 |
| 1 | CAGED | FORB | PHLOX LONGIFOLIA | 0.6 | 6.0 | 5.3 |
| 1 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 1 | CAGED | GRASS | AGROPYRON SPECIES | 2.5 | 25.0 | 22.2 |
| 1 | CAGED | GRASS | CAREX SPECIES | 0.3 | 3.0 | 2.7 |
| 1 | CAGED | GRASS | KOELERIA MACRANTHA | 6.7 | 67.0 | 59.6 |
| 1 | CAGED | GRASS | POA SPECIES | 2.7 | 27.0 | 24.0 |
| 1 | CAGED | GRASS | STIPA COMATA | 10.1 | 101.0 | 89.9 |
| 2 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 2.2 | 22.0 | 19.6 |
| 2 | UNCAGED | FORB | CRUCIFERAE SPECIES | 0.1 | 1.0 | 0.9 |
| 2 | UNCAGED | FORB | CRYPTANTHA SERICEA | 7.9 | 79.0 | 70.3 |
| 2 | UNCAGED | FORB | HEDYSARUM BOREALE | 9.8 | 98.0 | 87.2 |
| 2 | UNCAGED | FORB | PHLOX HOODII | 5.1 | 51.0 | 45.4 |
| 2 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.7 | 7.0 | 6.2 |
| 2 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.3 | 23.0 | 20.5 |
| 2 | UNCAGED | GRASS | CAREX SPECIES | 2.2 | 22.0 | 19.6 |
| 2 | UNCAGED | GRASS | KOELERIA MACRANTHA | 8.4 | 84.0 | 74.8 |
| 2 | UNCAGED | GRASS | POA SPECIES | 23.9 | 239.0 | 212.7 |
| 3 | UNCAGED | FORB | CRYPTANTHA SERICEA | 1.5 | 15.0 | 13.3 |
| 3 | UNCAGED | FORB | ERIGERON EATONII | 0.6 | 6.0 | 5.3 |
| 3 | UNCAGED | FORB | PHLOX HOODII | 10.1 | 101.0 | 89.9 |
| 3 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 3 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.1 | 11.0 | 9.8 |
| 3 | UNCAGED | GRASS | AGROPYRON SPECIES | 2.4 | 24.0 | 21.4 |
| 3 | UNCAGED | GRASS | KOELERIA MACRANTHA | 18.1 | 181.0 | 161.1 |
| 3 | UNCAGED | GRASS | POA SPECIES | 18.2 | 182.0 | 162.0 |
| 3 | UNCAGED | GRASS | STIPA COMATA | 8.5 | 85.0 | 75.6 |
| 4 | CAGED | FORB | ERIGERON EATONII | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | FORB | HEDYSARUM BOREALE | 22.5 | 225.0 | 200.2 |
| 4 | CAGED | FORB | PHLOX HOODII | 3.3 | 33.0 | 29.4 |
| 4 | CAGED | FORB | PHLOX LONGIFOLIA | 0.2 | 2.0 | 1.8 |
| 4 | CAGED | FORB | SPHAERALCEA COCCINEA | 3.1 | 31.0 | 27.6 |
| 4 | CAGED | GRASS | AGROPYRON SPECIES | 2.9 | 29.0 | 25.8 |
| 4 | CAGED | GRASS | CAREX SPECIES | 0.1 | 1.0 | 0.9 |
| 4 | CAGED | GRASS | KOELERIA MACRANTHA | 4.0 | 40.0 | 35.6 |
| 4 | CAGED | GRASS | POA SPECIES | 2.8 | 28.0 | 24.9 |
| 4 | CAGED | GRASS | STIPA COMATA | 5.2 | 52.0 | 46.3 |
| 5 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 2.9 | 29.0 | 25.8 |
| 5 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 0.4 | 4.0 | 3.6 |
| 5 | UNCAGED | FORB | CRYPTANTHA SERICEA | 6.0 | 60.0 | 53.4 |
| 5 | UNCAGED | FORB | PHLOX HOODII | 29.9 | 299.0 | 266.1 |
| 5 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.1 | 1.0 | 0.9 |
| 5 | UNCAGED | GRASS | KOELERIA MACRANTHA | 4.7 | 47.0 | 41.8 |
| 5 | UNCAGED | GRASS | ORYZOPSIS HYMENOIDES | 10.6 | 106.0 | 94.3 |
| 5 | UNCAGED | GRASS | POA SPECIES | 1.0 | 10.0 | 8.9 |
| 6 | CAGED | | DATA MISSING | . | . | . |

APPENDIX • RANGE PRODUCTIVITY AND UTILIZATION DATA
TRANSECT= 50 VEGETATION TYPE= SAGEBRUSH
REPORT YEAR= 1982

| PLOT | EXCLOSURE | GROWTH FORM | PLANT SPECIES | GM/M2 | KG/HA | LBS/A |
|---|---|---|---|---|---|---|
| 7 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 4.7 | 47.0 | 41.8 |
| 7 | UNCAGED | FORB | CREPIS OCCIDENTALIS | 3.8 | 38.0 | 33.8 |
| 7 | UNCAGED | FORB | ERIGERON EATONII | 1.6 | 16.0 | 14.2 |
| 7 | UNCAGED | FORB | PHLOX HOODII | 21.8 | 218.0 | 194.0 |
| 7 | UNCAGED | FORB | PHLOX LONGIFOLIA | 0.1 | 1.0 | 0.9 |
| 7 | UNCAGED | GRASS | CAREX SPECIES | 4.6 | 46.0 | 40.9 |
| 7 | UNCAGED | GRASS | POA SPECIES | 7.5 | 75.0 | 66.7 |
| 7 | UNCAGED | GRASS | STIPA COMATA | 0.8 | 8.0 | 7.1 |
| 8 | CAGED | | DATA MISSING | . | . | . |
| 9 | UNCAGED | FORB | ASTRAGALUS DIVERSIFOLIUS | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | FORB | ERIGERON EATONII | 0.2 | 2.0 | 1.8 |
| 9 | UNCAGED | FORB | HEDYSARUM BOREALE | 6.7 | 67.0 | 59.6 |
| 9 | UNCAGED | FORB | SPHAERALCEA COCCINEA | 1.3 | 13.0 | 11.6 |
| 9 | UNCAGED | GRASS | AGROPYRON SPECIES | 0.5 | 5.0 | 4.4 |
| 9 | UNCAGED | GRASS | KOELERIA MACRANTHA | 5.4 | 54.0 | 48.1 |
| 9 | UNCAGED | GRASS | POA SPECIES | 8.6 | 86.0 | 76.5 |
| 9 | UNCAGED | GRASS | STIPA COMATA | 6.0 | 60.0 | 53.4 |
| 10 | CAGED | FORB | CREPIS OCCIDENTALIS | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | FORB | ERIGERON EATONII | 0.5 | 5.0 | 4.4 |
| 10 | CAGED | FORB | PHLOX HOODII | 33.7 | 337.0 | 299.9 |
| 10 | CAGED | FORB | SPHAERALCEA COCCINEA | 0.1 | 1.0 | 0.9 |
| 10 | CAGED | GRASS | CAREX SPECIES | 1.9 | 19.0 | 16.9 |
| 10 | CAGED | GRASS | KOELERIA MACRANTHA | 3.1 | 31.0 | 27.6 |
| 10 | CAGED | GRASS | POA SPECIES | 8.1 | 81.0 | 72.1 |
| 10 | CAGED | GRASS | STIPA COMATA | 6.5 | 65.0 | 57.8 |

| TRANSECT SUMMARIES | GRAMS/M2 | KILOGRAMS/HECTARE | POUNDS/ACRE |
|---|---|---|---|
| CAGED PLOTS | | | |
| FORBS | 71.2 | 712.0 | 633.7 |
| GRASSES | 56.9 | 569.0 | 506.4 |
| TOTAL CAGED | 128.1 | 1281 | 1140 |
| UNCAGED PLOTS | | | |
| FORBS | 118.9 | 1189 | 1058 |
| GRASSES | 133.8 | 1338 | 1191 |
| TOTAL UNCAGED | 4946 | 49461 | 44020 |

# APPENDIX 3-1.4

## Analyses for Range Production and Utilization Data

Duncan's Multiple Range Test results for significant main effect differences as identified for analyses summarized on Table 3-20.

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=MIXED BRUSH  GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=835  MSE=6481.14
HARMONIC MEAN OF CELL SIZES=93.7934

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | | | MEAN | N | TRANSECT |
|---|---|---|---|---|---|
| | A | | 50.305 | 79 | 34 |
| | A | | | | |
| B | A | | 47.544 | 107 | 3 |
| B | A | | | | |
| B | A | C | 46.651 | 93 | 33 |
| B | A | C | | | |
| B | A | C | 41.603 | 118 | 31 |
| B | A | C | | | |
| B | A | C | 36.968 | 128 | 4 |
| B | A | C | | | |
| B | A | C | 25.680 | 115 | 2 |
| B | A | C | | | |
| B | A | C | 23.949 | 82 | 32 |
| B | | C | | | |
| B | | C | 21.163 | 66 | 35 |
| | | C | | | |
| | | C | 19.887 | 92 | 1 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=MIXED BRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=473  MSE=3062.65
HARMONIC MEAN OF CELL SIZES=102.076

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 65.103 | 97 | 1981 |
| A | | | |
| B A | 55.000 | 128 | 1982 |
| B A | | | |
| B A C | 49.801 | 107 | 1980 |
| B C | | | |
| B C | 43.115 | 91 | 1979 |
| C | | | |
| C | 35.465 | 95 | 1978 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=MIXED BRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=473  MSE=3062.65
HARMONIC MEAN OF CELL SIZES=56.2937

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | | | MEAN | N | TRANSECT |
|---|---|---|---|---|---|
| | A | | 72.543 | 42 | 35 |
| | A | | | | |
| B | A | | 67.722 | 54 | 32 |
| B | A | | | | |
| B | A | C | 58.630 | 69 | 31 |
| B | A | C | | | |
| B | D | A C | 52.033 | 56 | 33 |
| B | D | C | | | |
| B | D | C | 49.004 | 64 | 3 |
| B | D | C | | | |
| B | D | C | 47.525 | 50 | 34 |
| | D | C | | | |
| | D | C | 42.045 | 67 | 2 |
| | D | C | | | |
| | D | C | 37.563 | 54 | 1 |
| | D | | | | |
| | D | | 31.536 | 62 | 4 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=PINYON JUNIPER  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=492  MSE=780.121
HARMONIC MEAN OF CELL SIZES=101.366

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 27.389 | 144 | 1981 |
| A | | | |
| A | 25.242 | 161 | 1982 |
| A | | | |
| B A | 22.658 | 89 | 1980 |
| B | | | |
| B C | 16.302 | 89 | 1979 |
| C | | | |
| C | 9.641 | 73 | 1978 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=552  MSE=10221.5
HARMONIC MEAN OF CELL SIZES=90.445

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 63.423 | 168 | 1981 |
| A | | | |
| B A | 44.615 | 221 | 1982 |
| B | | | |
| B | 28.723 | 48 | 1978 |
| B | | | |
| B | 19.642 | 94 | 1980 |
| B | | | |
| B | 18.839 | 75 | 1979 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED VEGETATION TYPE=SAGEBRUSH GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=552 MSE=10221.5
HARMONIC MEAN OF CELL SIZES=13.875

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 101.19 | 26 | 45 |
| A | | | |
| B A | 95.58 | 12 | 44 |
| B A | | | |
| B A | 90.02 | 41 | 41 |
| B A | | | |
| B A | 75.83 | 14 | 15 |
| B A | | | |
| B A | 57.17 | 57 | 20 |
| B A | | | |
| B A | 49.98 | 48 | 47 |
| B A | | | |
| B A | 49.46 | 39 | 50 |
| B A | | | |
| B A | 39.90 | 43 | 10 |
| B A | | | |
| B A | 31.84 | 81 | 39 |
| B A | | | |
| B A | 25.57 | 19 | 30 |
| B A | | | |
| B A | 20.85 | 48 | 22 |
| B A | | | |
| B A | 19.68 | 74 | 8 |
| B A | | | |
| B A | 17.63 | 98 | 38 |
| B A | | | |
| B A | 15.50 | 3 | 28 |
| B | | | |
| B | 7.75 | 3 | 14 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=759  MSE=2335.96
HARMONIC MEAN OF CELL SIZES=140.708

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 54.351 | 262 | 1982 |
| A | | | |
| B A | 47.431 | 225 | 1981 |
| B | | | |
| B | 38.769 | 121 | 1980 |
| B | | | |
| B | 37.544 | 100 | 1979 |
| C | 22.844 | 111 | 1978 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=UNCAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=759  MSE=2335.96
HARMONIC MEAN OF CELL SIZES=51.0031

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | | | MEAN | N | TRANSECT |
|---|---|---|---|---|---|
| | A | | 66.738 | 44 | 28 |
| | A | | | | |
| | A | | 62.824 | 34 | 45 |
| | A | | | | |
| B | A | | 59.028 | 36 | 50 |
| B | A | | | | |
| B | A | C | 55.619 | 42 | 47 |
| B | A | C | | | |
| B | A | C | 54.558 | 43 | 41 |
| B | A | C | | | |
| B | A | C | 53.701 | 68 | 15 |
| B | A | C | | | |
| B D | A | C | 51.107 | 66 | 30 |
| B D | A | C | | | |
| B D | A | C | 49.802 | 52 | 14 |
| B D | | C | | | |
| B D | E | C | 39.855 | 41 | 10 |
| B D | E | C | | | |
| B D | E | C | 37.773 | 72 | 39 |
| B D | E | C | | | |
| B D | E | C | 37.562 | 48 | 44 |
| D | E | C | | | |
| D | E | C | 33.425 | 74 | 22 |
| D | E | | | | |
| D | E | | 31.558 | 71 | 8 |
| D | E | | | | |
| D | E | | 30.374 | 67 | 38 |
| | E | | | | |
| | E | | 24.483 | 61 | 20 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=PINYON JUNIPER  GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=420  MSE=2209.32
HARMONIC MEAN OF CELL SIZES=19.0131

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 59.786 | 28 | 43 |
| A | | | |
| A | 59.231 | 13 | 46 |
| A | | | |
| A | 53.536 | 18 | 37 |
| A | | | |
| B A | 43.199 | 31 | 6 |
| B A | | | |
| B A | 37.292 | 24 | 49 |
| B A | | | |
| B A | 29.558 | 51 | 36 |
| B | | | |
| B | 18.600 | 5 | 48 |
| B | | | |
| B | 18.460 | 36 | 19 |
| B | | | |
| B | 17.818 | 33 | 40 |
| B | | | |
| B | 17.271 | 45 | 12 |
| B | | | |
| B | 17.113 | 36 | 17 |
| B | | | |
| B | 16.529 | 17 | 42 |
| B | | | |
| B | 14.986 | 72 | 16 |
| B | | | |
| B | 10.240 | 25 | 11 |
| B | | | |
| B | 9.742 | 24 | 5 |
| B | | | |
| B | 7.090 | 9 | 18 |
| B | | | |
| B | 6.752 | 17 | 7 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=PINYON JUNIPER  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=504  MSE=1059.28
HARMONIC MEAN OF CELL SIZES=103.413

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 33.903 | 154 | 1981 |
| A | | | |
| A | 33.401 | 157 | 1982 |
| A | | | |
| B A | 24.770 | 80 | 1979 |
| B | | | |
| B | 23.270 | 100 | 1980 |
| B | | | |
| B | 17.876 | 77 | 1978 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=PINYON JUNIPER  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=504  MSE=1059.28
HARMONIC MEAN OF CELL SIZES=26.2845

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | | MEAN | N | TRANSECT |
|---|---|---|---|---|
| | A | 52.900 | 20 | 46 |
| | A | | | |
| B | A | 38.319 | 38 | 17 |
| B | A | | | |
| B | A | 37.286 | 21 | 48 |
| B | A | | | |
| B | A | 35.223 | 14 | 6 |
| B | A | | | |
| B | A | 33.743 | 54 | 7 |
| B | A | | | |
| B | A | 33.355 | 44 | 37 |
| B | A | | | |
| B | A | 32.720 | 25 | 49 |
| B | | | | |
| B | | 28.793 | 29 | 43 |
| B | | | | |
| B | | 28.265 | 34 | 40 |
| B | | | | |
| B | | 26.671 | 43 | 12 |
| B | | | | |
| B | | 26.462 | 38 | 19 |
| B | | | | |
| B | | 25.320 | 25 | 11 |
| B | | | | |
| B | | 21.750 | 12 | 42 |
| B | | | | |
| B | | 20.935 | 53 | 16 |
| B | | | | |
| B | | 19.686 | 14 | 18 |
| B | | | | |
| B | | 19.560 | 69 | 36 |
| B | | | | |
| B | | 19.283 | 35 | 5 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=542  MSE=21882.7
HARMONIC MEAN OF CELL SIZES=102.489

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 92.982 | 166 | 1981 |
| B | 43.829 | 181 | 1982 |
| B | | | |
| B | 30.383 | 65 | 1978 |
| B | | | |
| B | 29.627 | 102 | 1980 |
| B | | | |
| B | 25.373 | 83 | 1979 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=542  MSE=21882.7
HARMONIC MEAN OF CELL SIZES=17.4197

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 272.68 | 19 | 41 |
| A | | | |
| A | 213.29 | 28 | 45 |
| A | | | |
| B A | 171.25 | 12 | 44 |
| B | | | |
| B C | 75.16 | 29 | 10 |
| C | | | |
| C | 47.23 | 54 | 22 |
| C | | | |
| C | 45.43 | 23 | 50 |
| C | | | |
| C | 44.85 | 57 | 20 |
| C | | | |
| C | 35.27 | 7 | 28 |
| C | | | |
| C | 32.84 | 18 | 30 |
| C | | | |
| C | 27.68 | 121 | 38 |
| C | | | |
| C | 24.86 | 77 | 39 |
| C | | | |
| C | 21.56 | 52 | 47 |
| C | | | |
| C | 17.92 | 87 | 8 |
| C | | | |
| C | 12.28 | 8 | 15 |
| C | | | |
| C | 10.40 | 5 | 14 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=798  MSE=5468.01
HARMONIC MEAN OF CELL SIZES=150.994

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 63.212 | 241 | 1981 |
| A | | | |
| A | 62.000 | 124 | 1980 |
| A | | | |
| A | 60.187 | 257 | 1982 |
| A | | | |
| A | 59.622 | 111 | 1979 |
| B | 33.807 | 125 | 1978 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

TWO-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS AND REPORT YEAR
BY GROWTH FORM AND CAGE EXCLOSURE, WITHIN THREE VEGETATION TYPES
CAGE EXCLOSURE=CAGED  VEGETATION TYPE=SAGEBRUSH  GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05  DF=798  MSE=5468.01
HARMONIC MEAN OF CELL SIZES=53.5646

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 126.26 | 55 | 15 |
| A | | | |
| A | 119.28 | 51 | 28 |
| B | 62.42 | 67 | 30 |
| B | 60.02 | 44 | 45 |
| B | | | |
| B | 54.21 | 51 | 10 |
| B | | | |
| B | 52.88 | 72 | 14 |
| B | | | |
| B | 52.09 | 43 | 41 |
| B | | | |
| B | 52.05 | 64 | 39 |
| B | | | |
| B | 52.04 | 53 | 20 |
| B | | | |
| B | 49.61 | 31 | 50 |
| B | | | |
| B | 49.38 | 47 | 47 |
| B | | | |
| B | 44.37 | 49 | 44 |
| B | | | |
| B | 39.03 | 71 | 8 |
| B | | | |
| B | 35.85 | 71 | 38 |
| B | | | |
| B | 35.20 | 89 | 22 |

Duncan's Multiple Range Test results for significant main effect differences for analyses summarized on Table 3-21.

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS
BY GROWTH FORM, WITHIN THREE VEGETATION TYPES
FOR THE UNCAGED PLOTS (CAGE EXCLOSURE= UNCAGED)
RPTYR=1982 VEGETATION TYPE=PINYON JUNIPER GROWTH FORM=FORB

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=151 MSE=7288.61
HARMONIC MEAN OF CELL SIZES=5.53079

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 165.78 | 9 | 36 |
| A | | | |
| B A | 87.75 | 4 | 46 |
| B | | | |
| B | 31.00 | 4 | 40 |
| B | | | |
| B | 26.56 | 9 | 6 |
| B | | | |
| B | 20.08 | 13 | 42 |
| B | | | |
| B | 19.87 | 8 | 11 |
| B | | | |
| B | 19.33 | 15 | 49 |
| B | | | |
| B | 16.77 | 13 | 19 |
| B | | | |
| B | 16.17 | 12 | 43 |
| B | | | |
| B | 15.55 | 20 | 5 |
| B | | | |
| B | 15.33 | 6 | 48 |
| B | | | |
| B | 15.31 | 13 | 12 |
| B | | | |
| B | 15.21 | 14 | 17 |
| B | | | |
| B | 12.33 | 3 | 37 |
| B | | | |
| B | 7.91 | 23 | 16 |
| B | | | |
| B | 1.00 | 1 | 7 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS
BY GROWTH FORM, WITHIN THREE VEGETATION TYPES
FOR THE UNCAGED PLOTS (CAGE EXCLOSURE= UNCAGED)
RPTYR=1982 VEGETATION TYPE=SAGEBRUSH GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=247 MSE=4209.16
HARMONIC MEAN OF CELL SIZES=16.0228

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 117.91 | 11 | 28 |
| A | | | |
| B A | 108.09 | 11 | 14 |
| B A | | | |
| B A C | 79.38 | 13 | 15 |
| B A C | 72.30 | 10 | 10 |
| B A C | | | |
| B A C | 70.42 | 19 | 50 |
| B C | | | |
| B C | 64.05 | 21 | 41 |
| B C | | | |
| B C | 60.83 | 18 | 39 |
| B C | | | |
| B C | 60.67 | 21 | 45 |
| C | | | |
| C | 48.87 | 24 | 47 |
| C | | | |
| C | 41.85 | 13 | 30 |
| C | | | |
| C | 35.00 | 25 | 44 |
| C | | | |
| C | 33.26 | 23 | 22 |
| C | | | |
| C | 31.53 | 15 | 20 |
| C | | | |
| C | 29.95 | 19 | 8 |
| C | | | |
| C | 28.84 | 19 | 38 |

RIO BLANCO OIL SHALE COMPANY
VEGETATION MONITORING PROGRAM
RANGE PRODUCTIVITY AND UTILIZATION STUDIES

ONE-WAY ANALYSIS OF VARIANCE COMPARING TRANSECTS
BY GROWTH FORM, WITHIN THREE VEGETATION TYPES
FOR THE CAGED PLOTS (CAGE EXCLOSURE = CAGED)
RPTYR=1982 VEGETATION TYPE=SAGEBRUSH GROWTH FORM=GRASS

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: KG_HA
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=242 MSE=5196.3
HARMONIC MEAN OF CELL SIZES=15.1821

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | TRANSECT |
|---|---|---|---|
| A | 168.30 | 10 | 28 |
| A | | | |
| B A | 136.33 | 15 | 15 |
| B | | | |
| B C | 88.50 | 12 | 10 |
| C | | | |
| C | 71.87 | 15 | 39 |
| C | | | |
| C | 65.14 | 22 | 41 |
| C | | | |
| C | 60.05 | 21 | 45 |
| C | | | |
| C | 59.57 | 7 | 20 |
| C | | | |
| C | 51.25 | 16 | 14 |
| C | | | |
| C | 49.81 | 26 | 47 |
| C | | | |
| C | 48.00 | 17 | 38 |
| C | | | |
| C | 40.64 | 14 | 50 |
| C | | | |
| C | 39.90 | 21 | 8 |
| C | | | |
| C | 39.48 | 23 | 44 |
| C | | | |
| C | 33.96 | 24 | 22 |
| C | | | |
| C | 30.57 | 14 | 30 |

# APPENDIX 3-2

## Mule Deer Studies

# APPENDIX 3-2.1

## 1982 Summer Mule Deer Pellet Group Data

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 30SEP82 | 7000 | 20 | SE | MP | 1 | 1 | 1 |
| 1 | 5 | 30SEP82 | 7000 | 20 | SE | MP | 1 | 2 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 20 | SE | MP | 1 | 3 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 20 | S | MP | 1 | 4 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | SE | OT | 1 | 5 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | SE | MB | 1 | 6 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | E | MP | 1 | 7 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | NE | MB | 1 | 8 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | N | MB | 1 | 9 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 20 | N | MB | 1 | 10 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 30 | N | MB | 2 | 1 | 1 |
| 1 | 5 | 30SEP82 | 7000 | 10 | NW | SB | 2 | 2 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | SE | SB | 2 | 3 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 20 | E | MB | 2 | 4 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 50 | S | MB | 2 | 5 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | E | SP | 2 | 6 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | E | MP | 2 | 7 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | E | MP | 2 | 8 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 20 | SE | MP | 2 | 9 | 0 |
| 1 | 5 | 30SEP82 | 7000 | 10 | SE | MP | 2 | 10 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | E | MB | 1 | 1 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | E | MB | 1 | 2 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | N | MB | 1 | 3 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | SE | SB | 1 | 4 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | S | MP | 1 | 5 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | SE | MB | 1 | 6 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | SE | MB | 1 | 7 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | NW | MB | 1 | 8 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | NW | MB | 1 | 9 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | N | MB | 1 | 10 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | N | MB | 2 | 1 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | 0 | MB | 2 | 2 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | N | MP | 2 | 3 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | NW | MP | 2 | 4 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | 0 | MP | 2 | 5 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | NW | MP | 2 | 6 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | N | MB | 2 | 7 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 20 | N | MB | 2 | 8 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | 0 | SB | 2 | 9 | 0 |
| 1 | 11 | 30SEP82 | 7000 | 10 | E | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 16 | 30SEP82 | 7500 | 10 | E | MB | 1 | 1 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 50 | SE | MB | 1 | 2 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 50 | NE | MB | 1 | 3 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 30 | SE | MB | 1 | 4 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 20 | E | MB | 1 | 5 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | S | MB | 1 | 6 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 20 | SW | MP | 1 | 7 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 20 | S | MP | 1 | 8 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | SE | MP | 1 | 9 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | S | MP | 1 | 10 | 0 |
| 1 | 16 | 30SEP82 | 7000 | 30 | S | MP | 2 | 1 | 0 |
| 1 | 16 | 30SEP82 | 7000 | 10 | N | MB | 2 | 2 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 20 | SW | MB | 2 | 3 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 30 | SW | MP | 2 | 4 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | W | SB | 2 | 5 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | 0 | MP | 2 | 6 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | 0 | MP | 2 | 7 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | 0 | MP | 2 | 8 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | NE | MB | 2 | 9 | 0 |
| 1 | 16 | 30SEP82 | 7500 | 10 | E | MB | 2 | 10 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 10 | 0 | SB | 1 | 1 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 50 | S | MB | 1 | 2 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 50 | SW | MB | 1 | 3 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | SW | OT | 1 | 4 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | SW | MB | 1 | 5 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | W | MB | 1 | 6 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 30 | W | MB | 1 | 7 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | SE | MB | 1 | 8 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | S | MB | 1 | 9 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | S | MB | 1 | 10 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 50 | W | MB | 2 | 1 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 50 | W | OT | 2 | 2 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 40 | W | OT | 2 | 3 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 40 | W | OT | 2 | 4 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 30 | W | MB | 2 | 5 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 30 | SW | MB | 2 | 6 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 30 | S | MB | 2 | 7 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 30 | S | MB | 2 | 8 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 20 | S | MB | 2 | 9 | 0 |
| 1 | 20 | 30SEP82 | 7500 | 10 | SE | MB | 2 | 10 | 2 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 23 | 24SEP82 | 7000 | 10 | W | MB | 1 | 1 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | SE | MB | 1 | 2 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | E | MB | 1 | 3 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 40 | NE | MB | 1 | 4 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | NE | MB | 1 | 5 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | S | SB | 1 | 6 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | SW | OT | 1 | 7 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | SW | SP | 1 | 8 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 20 | S | MP | 1 | 9 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | 0 | MP | 1 | 10 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 30 | S | MP | 2 | 1 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 20 | NE | MB | 2 | 2 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 50 | S | MB | 2 | 3 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | S | SP | 2 | 4 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 40 | W | SP | 2 | 5 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 40 | SW | MP | 2 | 6 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 30 | SW | MP | 2 | 7 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | S | SP | 2 | 8 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 10 | S | MP | 2 | 9 | 0 |
| 1 | 23 | 24SEP82 | 7000 | 20 | N | MP | 2 | 10 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 20 | S | MB | 1 | 1 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 20 | S | MB | 1 | 2 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 10 | N | MB | 1 | 3 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 40 | N | MB | 1 | 4 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 50 | N | MB | 1 | 5 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 50 | N | MB | 1 | 6 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 50 | N | MB | 1 | 7 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 20 | N | MB | 1 | 8 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 10 | S | SB | 1 | 9 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 50 | S | MB | 1 | 10 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 40 | NW | MB | 2 | 1 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 30 | NW | MB | 2 | 2 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 20 | SE | SB | 2 | 3 | 2 |
| 1 | 26 | 30SEP82 | 7500 | 30 | SE | OT | 2 | 4 | 0 |
| 1 | 26 | 30SEP82 | 7500 | 10 | S | MB | 2 | 5 | 0 |
| 1 | 26 | 30SEP82 | 7000 | 10 | 0 | MB | 2 | 6 | 0 |
| 1 | 26 | 30SEP82 | 7000 | 50 | N | MB | 2 | 7 | 0 |
| 1 | 26 | 30SEP82 | 7000 | 50 | N | MB | 2 | 8 | 1 |
| 1 | 26 | 30SEP82 | 7000 | 10 | N | SB | 2 | 9 | 0 |
| 1 | 26 | 30SEP82 | 7000 | 50 | S | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 31 | 30SEP82 | 7500 | 10 | SW | MB | 1 | 1 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 20 | S | MB | 1 | 2 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 20 | S | MB | 1 | 3 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 10 | SE | MB | 1 | 4 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 20 | NE | MB | 1 | 5 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 30 | NW | MB | 1 | 6 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 30 | N | MB | 1 | 7 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 30 | NE | MB | 1 | 8 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 40 | NE | MB | 1 | 9 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 40 | NE | MB | 1 | 10 | 1 |
| 1 | 31 | 30SEP82 | 7500 | 10 | SW | MB | 2 | 1 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 30 | SW | MB | 2 | 2 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 10 | E | SB | 2 | 3 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 20 | SE | MB | 2 | 4 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 20 | SE | MB | 2 | 5 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 30 | SE | MB | 2 | 6 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 10 | 0 | MB | 2 | 7 | 0 |
| 1 | 31 | 30SEP82 | 7500 | 10 | N | MB | 2 | 8 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 30 | N | MB | 2 | 9 | 0 |
| 1 | 31 | 30SEP82 | 8000 | 30 | N | MB | 2 | 10 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | N | MP | 1 | 1 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 1 | 2 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 1 | 3 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 1 | 4 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 20 | E | SB | 1 | 5 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 40 | SW | MP | 1 | 6 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 30 | S | MP | 1 | 7 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | S | MP | 1 | 8 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | MP | 1 | 9 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 20 | NE | MP | 1 | 10 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 20 | N | MP | 2 | 1 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 20 | N | PJ | 2 | 2 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 20 | N | MP | 2 | 3 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | N | MB | 2 | 4 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 2 | 5 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 2 | 6 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | 0 | SB | 2 | 7 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 30 | SW | MP | 2 | 8 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | SE | MP | 2 | 9 | 0 |
| 2 | 5 | 23SEP82 | 6500 | 10 | SE | PJ | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 6 | 23SEP82 | 6500 | 10 | N | PJ | 1 | 1 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NW | PJ | 1 | 2 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NW | PJ | 1 | 3 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 20 | N | MP | 1 | 4 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 20 | S | PJ | 1 | 5 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NW | PJ | 1 | 6 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 30 | NW | MP | 1 | 7 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | N | SB | 1 | 8 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | 0 | SB | 1 | 9 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | S | SB | 1 | 10 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | E | SP | 2 | 1 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | SE | PJ | 2 | 2 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NE | SP | 2 | 3 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NE | PJ | 2 | 4 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NE | PJ | 2 | 5 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | N | PJ | 2 | 6 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 10 | NE | MP | 2 | 7 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 20 | E | MP | 2 | 8 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 20 | E | MP | 2 | 9 | 0 |
| 2 | 6 | 23SEP82 | 6500 | 20 | N | SP | 2 | 10 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | 0 | SP | 1 | 1 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 10 | E | SP | 1 | 2 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | E | SP | 1 | 3 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | E | MP | 1 | 4 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | MP | 1 | 5 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | MP | 1 | 6 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | MP | 1 | 7 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | MP | 1 | 8 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | N | MP | 1 | 9 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 20 | N | MP | 1 | 10 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | SP | 2 | 1 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | NW | SP | 2 | 2 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | N | SP | 2 | 3 | 0 |
| 2 | 15 | 23SEP82 | 7000 | 10 | N | SP | 2 | 4 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 10 | N | MP | 2 | 5 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 10 | N | MP | 2 | 6 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 20 | SW | MP | 2 | 7 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 10 | NW | MP | 2 | 8 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 20 | N | MP | 2 | 9 | 0 |
| 2 | 15 | 23SEP82 | 6500 | 30 | N | MP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 17 | 22SEP82 | 6500 | 10 | S | PJ | 1 | 1 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | NE | PJ | 1 | 2 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | NE | PJ | 1 | 3 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 4 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 5 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 6 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 7 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | SP | 1 | 8 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | SP | 1 | 9 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | SP | 1 | 10 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | SP | 2 | 1 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | 0 | SP | 2 | 2 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | SE | PJ | 2 | 3 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 4 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 5 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 6 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 7 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | 0 | SP | 2 | 8 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | 0 | SB | 2 | 9 | 0 |
| 2 | 17 | 22SEP82 | 6500 | 10 | SE | PJ | 2 | 10 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 20 | N | PJ | 1 | 1 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 2 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 3 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 4 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | PJ | 1 | 5 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | SP | 1 | 6 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | NW | SP | 1 | 7 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | NW | SP | 1 | 8 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | NW | SP | 1 | 9 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 10 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | NE | SP | 2 | 1 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | NE | SP | 2 | 2 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | SB | 2 | 3 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | SE | PJ | 2 | 4 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | SE | PJ | 2 | 5 | 1 |
| 2 | 24 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 6 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 7 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 8 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 9 | 0 |
| 2 | 24 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SP | 1 | 1 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 2 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 3 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 4 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 5 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 6 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | NE | SB | 1 | 7 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 8 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 9 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 1 | 10 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | E | PJ | 2 | 1 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | E | PJ | 2 | 2 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SP | 2 | 3 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SP | 2 | 4 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SP | 2 | 5 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SP | 2 | 6 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 2 | 7 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 2 | 8 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 2 | 9 | 0 |
| 2 | 28 | 21SEP82 | 7000 | 10 | N | SB | 2 | 10 | 1 |
| 2 | 34 | 21SEP82 | 7000 | 10 | NE | PJ | 1 | 1 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | PJ | 1 | 2 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | SP | 1 | 3 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | SP | 1 | 4 | 1 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | SP | 1 | 5 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | MP | 1 | 6 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | MP | 1 | 7 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | PJ | 1 | 8 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 1 | 9 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 1 | 10 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | 0 | SP | 2 | 1 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 2 | 2 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 2 | 3 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 2 | 4 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | N | SP | 2 | 5 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | E | SB | 2 | 6 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | S | SB | 2 | 7 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | SE | PJ | 2 | 8 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | SE | PJ | 2 | 9 | 0 |
| 2 | 34 | 21SEP82 | 7000 | 10 | SE | PJ | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 1 | 21SEP82 | 6500 | 30 | SE | SP | 1 | 1 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 2 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 3 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 4 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | N | SP | 1 | 5 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 6 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 7 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 8 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 9 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | NW | SP | 1 | 10 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 1 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 2 | 1 |
| 3 | 1 | 21SEP82 | 6500 | 10 | N | SP | 2 | 3 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 4 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 5 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | S | SB | 2 | 6 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 7 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | N | SB | 2 | 8 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 9 | 0 |
| 3 | 1 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 10 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 20 | S | SP | 1 | 1 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | S | SP | 1 | 2 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 3 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 4 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 5 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 6 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 7 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 8 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 9 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 10 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | S | SP | 2 | 1 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | MP | 2 | 2 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | N | SP | 2 | 3 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | N | SP | 2 | 4 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 5 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | N | SB | 2 | 6 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | S | SB | 2 | 7 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | N | SB | 2 | 8 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | SE | SB | 2 | 9 | 0 |
| 3 | 11 | 21SEP82 | 6500 | 10 | S | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 1 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 2 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 3 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | SE | SP | 1 | 4 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | SE | PJ | 1 | 5 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | SE | PJ | 1 | 6 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | SE | PJ | 1 | 7 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | NE | SP | 1 | 8 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | N | SP | 1 | 9 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 10 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | N | SP | 2 | 1 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | N | SB | 2 | 2 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 3 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 4 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 5 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 6 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | W | SB | 2 | 7 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | S | SP | 2 | 8 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 9 | 0 |
| 3 | 14 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 10 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 1 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 2 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 3 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 4 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 5 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 6 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 7 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | N | SB | 1 | 8 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | S | SP | 1 | 9 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 20 | S | MP | 1 | 10 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | W | SB | 2 | 1 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 2 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 3 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | N | SB | 2 | 4 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 5 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 6 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 7 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | N | SB | 2 | 8 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | SE | SB | 2 | 9 | 0 |
| 3 | 17 | 21SEP82 | 6500 | 10 | S | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 1 | 1 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | W | SB | 1 | 2 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | W | SB | 1 | 3 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 1 | 4 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 5 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | N | SB | 1 | 6 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | N | SB | 1 | 7 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | NW | SB | 1 | 8 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 20 | W | SB | 1 | 9 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 1 | 10 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 1 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 2 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 3 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 4 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 5 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 6 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 7 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 2 | 8 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 2 | 9 | 0 |
| 3 | 18 | 21SEP82 | 6500 | 10 | SW | SB | 2 | 10 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SP | 1 | 1 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | 0 | SP | 1 | 2 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | NW | SB | 1 | 3 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | NW | SB | 1 | 4 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SB | 1 | 5 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SB | 1 | 6 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 7 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | 0 | SB | 1 | 8 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | SE | PJ | 1 | 9 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 20 | SW | PJ | 1 | 10 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 1 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 2 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SP | 2 | 3 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SP | 2 | 4 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SB | 2 | 5 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | SE | SP | 2 | 6 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | E | PJ | 2 | 7 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | SE | PJ | 2 | 8 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | NE | PJ | 2 | 9 | 0 |
| 3 | 19 | 21SEP82 | 6500 | 10 | N | SP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | SB | 1 | 1 | 1 |
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | SB | 1 | 2 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | MB | 1 | 3 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 50 | S | MP | 1 | 4 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 40 | SE | MP | 1 | 5 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 20 | SE | SB | 1 | 6 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 50 | SW | MP | 1 | 7 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 10 | S | PJ | 1 | 8 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 10 | 0 | PJ | 1 | 9 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 10 | NE | SP | 1 | 10 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 20 | NW | MP | 2 | 1 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 40 | NW | MP | 2 | 2 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 10 | NW | SB | 2 | 3 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | SB | 2 | 4 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | SB | 2 | 5 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 10 | 0 | SB | 2 | 6 | 0 |
| 3 | 34 | 21SEP82 | 6000 | 50 | E | MP | 2 | 7 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 50 | E | MP | 2 | 8 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 40 | E | SP | 2 | 9 | 0 |
| 3 | 34 | 21SEP82 | 6500 | 10 | 0 | SP | 2 | 10 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | S | MB | 1 | 1 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | N | OT | 1 | 2 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 10 | E | SB | 1 | 3 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | S | MB | 1 | 4 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 30 | SE | MB | 1 | 5 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 40 | SE | MB | 1 | 6 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 40 | SE | MB | 1 | 7 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 30 | SE | MB | 1 | 8 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 30 | SE | MB | 1 | 9 | 0 |
| 4 | 1 | 30SEP82 | 8000 | 30 | SE | MB | 1 | 10 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | N | MB | 2 | 1 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | N | MB | 2 | 2 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 40 | N | MB | 2 | 3 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 10 | E | MB | 2 | 4 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | S | MP | 2 | 5 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 50 | SE | MP | 2 | 6 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 30 | SE | MB | 2 | 7 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 40 | E | MB | 2 | 8 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 40 | E | MB | 2 | 9 | 0 |
| 4 | 1 | 30SEP82 | 7500 | 10 | SE | MB | 2 | 10 | 0 |

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WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 8 | 16SEP82 | 7500 | 20 | N | MB | 1 | 1 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 30 | N | MB | 1 | 2 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | SE | MB | 1 | 3 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 30 | SE | MB | 1 | 4 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 20 | S | MB | 1 | 5 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | SE | MB | 1 | 6 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | SE | MB | 1 | 7 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | SE | MB | 1 | 8 | 0 |
| 4 | 8 | 16SEP82 | 8000 | 20 | S | MB | 1 | 9 | 0 |
| 4 | 8 | 16SEP82 | 8000 | 10 | 0 | MB | 1 | 10 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | N | MB | 2 | 1 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 20 | N | MB | 2 | 2 | 1 |
| 4 | 8 | 16SEP82 | 7500 | 20 | N | MB | 2 | 3 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 10 | S | MB | 2 | 4 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 30 | S | MB | 2 | 5 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 20 | SE | MB | 2 | 6 | 1 |
| 4 | 8 | 16SEP82 | 7500 | 30 | E | MB | 2 | 7 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 20 | E | MB | 2 | 8 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 20 | SE | MB | 2 | 9 | 0 |
| 4 | 8 | 16SEP82 | 7500 | 30 | E | MB | 2 | 10 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | 0 | MB | 1 | 1 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SW | OT | 1 | 2 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SW | OT | 1 | 3 | 0 |
| 4 | 13 | 23SEP82 | 8000 | 10 | S | MB | 1 | 4 | 0 |
| 4 | 13 | 23SEP82 | 8000 | 20 | S | MB | 1 | 5 | 0 |
| 4 | 13 | 23SEP82 | 8000 | 10 | 0 | MB | 1 | 6 | 1 |
| 4 | 13 | 23SEP82 | 8000 | 10 | W | MB | 1 | 7 | 0 |
| 4 | 13 | 23SEP82 | 8000 | 10 | W | MB | 1 | 8 | 0 |
| 4 | 13 | 23SEP82 | 8000 | 10 | S | MB | 1 | 9 | 1 |
| 4 | 13 | 23SEP82 | 8000 | 10 | N | MB | 1 | 10 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SE | MB | 2 | 1 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SW | MB | 2 | 2 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 20 | SW | MB | 2 | 3 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 20 | SW | OT | 2 | 4 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SW | OT | 2 | 5 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 20 | SW | OT | 2 | 6 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | SW | OT | 2 | 7 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | 0 | OT | 2 | 8 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | N | OT | 2 | 9 | 0 |
| 4 | 13 | 23SEP82 | 7500 | 10 | N | OT | 2 | 10 | 0 |

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WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 14 | 20SEP82 | 7500 | 30 | E | MB | 1 | 1 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 30 | E | MB | 1 | 2 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 30 | E | MB | 1 | 3 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 30 | E | MB | 1 | 4 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | SE | MB | 1 | 5 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 30 | E | MB | 1 | 6 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | E | MB | 1 | 7 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | S | MB | 1 | 8 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | S | MB | 1 | 9 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | 0 | MB | 1 | 10 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 50 | SW | MB | 2 | 1 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 30 | SW | MB | 2 | 2 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | SW | MB | 2 | 3 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | W | MB | 2 | 4 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | SE | MB | 2 | 5 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | SE | MB | 2 | 6 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 20 | SE | MB | 2 | 7 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | N | MB | 2 | 8 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | SW | MB | 2 | 9 | 0 |
| 4 | 14 | 20SEP82 | 7500 | 10 | SW | MB | 2 | 10 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 20 | N | MB | 1 | 1 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 20 | N | MB | 1 | 2 | 1 |
| 4 | 18 | 23SEP82 | 7000 | 20 | N | MB | 1 | 3 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 20 | S | SB | 1 | 4 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 40 | S | PJ | 1 | 5 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 10 | S | MP | 1 | 6 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 10 | S | PJ | 1 | 7 | 0 |
| 4 | 18 | 23SEP82 | 7000 | 10 | S | PJ | 1 | 8 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 10 | S | PJ | 1 | 9 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 30 | S | PJ | 1 | 10 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 40 | N | MB | 2 | 1 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 20 | S | SB | 2 | 2 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 10 | S | SB | 2 | 3 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 20 | S | SB | 2 | 4 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 20 | S | SB | 2 | 5 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 40 | E | SB | 2 | 6 | 1 |
| 4 | 18 | 23SEP82 | 7500 | 40 | E | SB | 2 | 7 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 40 | E | SP | 2 | 8 | 1 |
| 4 | 18 | 23SEP82 | 7500 | 30 | E | SP | 2 | 9 | 0 |
| 4 | 18 | 23SEP82 | 7500 | 10 | E | SP | 2 | 10 | 0 |

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WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 23 | 22SEP82 | 7000 | 30 | S | MB | 1 | 1 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 10 | O | OT | 1 | 2 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 30 | E | MB | 1 | 3 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 30 | E | MB | 1 | 4 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 40 | E | MB | 1 | 5 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 30 | E | MB | 1 | 6 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 20 | SE | MP | 1 | 7 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | S | MP | 1 | 8 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | O | MB | 1 | 9 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | E | MB | 1 | 10 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 40 | S | MP | 2 | 1 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 30 | S | SP | 2 | 2 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 30 | S | SP | 2 | 3 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 30 | E | MP | 2 | 4 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | S | MP | 2 | 5 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | SE | MP | 2 | 6 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 10 | NW | MP | 2 | 7 | 0 |
| 4 | 23 | 22SEP82 | 7500 | 20 | NW | MB | 2 | 8 | 1 |
| 4 | 23 | 22SEP82 | 7000 | 30 | NW | MB | 2 | 9 | 0 |
| 4 | 23 | 22SEP82 | 7000 | 20 | E | MB | 2 | 10 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 30 | S | SB | 1 | 1 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | SW | OT | 1 | 2 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | S | MB | 1 | 3 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | W | OT | 1 | 4 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | W | OT | 1 | 5 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | S | MB | 1 | 6 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | S | MB | 1 | 7 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | N | MB | 1 | 8 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 40 | N | MB | 1 | 9 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 40 | N | MB | 1 | 10 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 20 | SW | MB | 2 | 1 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 20 | W | MB | 2 | 2 | 1 |
| 4 | 25 | 22SEP82 | 7500 | 20 | S | MB | 2 | 3 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 20 | S | OT | 2 | 4 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 20 | S | MB | 2 | 5 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | SW | OT | 2 | 6 | 0 |
| 4 | 25 | 22SEP82 | 8000 | 10 | W | OT | 2 | 7 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 10 | N | MB | 2 | 8 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 10 | N | MB | 2 | 9 | 0 |
| 4 | 25 | 22SEP82 | 7500 | 20 | N | MB | 2 | 10 | 0 |

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WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 8 | 20SEP82 | 7000 | 10 | SE | MP | 1 | 1 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 1 | 2 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | SB | 1 | 3 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 1 | 4 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 1 | 5 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 1 | 6 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 1 | 7 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 20 | N | MB | 1 | 8 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 20 | S | MB | 1 | 9 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | S | MB | 1 | 10 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | E | MP | 2 | 1 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | E | SB | 2 | 2 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | NE | MB | 2 | 3 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | E | MB | 2 | 4 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | S | MB | 2 | 5 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | S | MB | 2 | 6 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | 0 | MB | 2 | 7 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | SB | 2 | 8 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | MB | 2 | 9 | 0 |
| 5 | 8 | 20SEP82 | 7000 | 10 | N | SB | 2 | 10 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 50 | S | SP | 1 | 1 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | S | SP | 1 | 2 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 40 | S | SP | 1 | 3 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 40 | S | OT | 1 | 4 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 20 | S | SP | 1 | 5 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 40 | S | SB | 1 | 6 | 1 |
| 5 | 13 | 21SEP82 | 7000 | 10 | 0 | MP | 1 | 7 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | N | MP | 1 | 8 | 1 |
| 5 | 13 | 21SEP82 | 7000 | 20 | W | MP | 1 | 9 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 20 | W | MP | 1 | 10 | 0 |
| 5 | 13 | 21SEP82 | 6500 | 10 | N | MB | 2 | 1 | 0 |
| 5 | 13 | 21SEP82 | 6500 | 10 | 0 | SB | 2 | 2 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 40 | S | SB | 2 | 3 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 20 | S | MP | 2 | 4 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | SE | MP | 2 | 5 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 20 | E | SB | 2 | 6 | 2 |
| 5 | 13 | 21SEP82 | 7000 | 30 | E | SB | 2 | 7 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | SE | MP | 2 | 8 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | SE | MP | 2 | 9 | 0 |
| 5 | 13 | 21SEP82 | 7000 | 10 | 0 | MP | 2 | 10 | 0 |

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REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 15 | 17SEP82 | 7000 | 10 | N | MP | 1 | 1 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | NW | MB | 1 | 2 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | NW | MP | 1 | 3 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | N | MP | 1 | 4 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 10 | N | MP | 1 | 5 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 10 | N | MP | 1 | 6 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 30 | NW | MP | 1 | 7 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 10 | 0 | SB | 1 | 8 | 1 |
| 5 | 15 | 17SEP82 | 6500 | 10 | 0 | SB | 1 | 9 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 40 | S | SP | 1 | 10 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | E | PJ | 2 | 1 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | 0 | PJ | 2 | 2 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | N | SP | 2 | 3 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | W | PJ | 2 | 4 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 30 | N | SP | 2 | 5 | 0 |
| 5 | 15 | 17SEP82 | 7000 | 10 | N | SB | 2 | 6 | 2 |
| 5 | 15 | 17SEP82 | 6500 | 10 | N | SB | 2 | 7 | 1 |
| 5 | 15 | 17SEP82 | 6500 | 10 | N | SP | 2 | 8 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 10 | N | MP | 2 | 9 | 0 |
| 5 | 15 | 17SEP82 | 6500 | 20 | N | MP | 2 | 10 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 1 | 1 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 20 | W | SB | 1 | 2 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 20 | W | SP | 1 | 3 | 1 |
| 5 | 27 | 16SEP82 | 7000 | 10 | N | SP | 1 | 4 | 2 |
| 5 | 27 | 16SEP82 | 7000 | 20 | N | MB | 1 | 5 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 20 | N | MB | 1 | 6 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | N | MB | 1 | 7 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 20 | N | MB | 1 | 8 | 0 |
| 5 | 27 | 16SEP82 | 6500 | 40 | N | MB | 1 | 9 | 0 |
| 5 | 27 | 16SEP82 | 6500 | 30 | N | MB | 1 | 10 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 2 | 1 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 2 | 2 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 2 | 3 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 2 | 4 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | 0 | SP | 2 | 5 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | N | SP | 2 | 6 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 10 | N | SP | 2 | 7 | 1 |
| 5 | 27 | 16SEP82 | 7000 | 10 | N | SP | 2 | 8 | 0 |
| 5 | 27 | 16SEP82 | 7000 | 20 | N | SB | 2 | 9 | 0 |
| 5 | 27 | 16SEP82 | 6500 | 30 | N | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 28 | 16SEP82 | 7000 | 10 | 0 | SB | 1 | 1 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 10 | S | SB | 1 | 2 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 30 | E | MP | 1 | 3 | 2 |
| 5 | 28 | 16SEP82 | 7000 | 30 | S | PJ | 1 | 4 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 10 | N | MP | 1 | 5 | 3 |
| 5 | 28 | 16SEP82 | 7000 | 20 | E | SP | 1 | 6 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 20 | S | PJ | 1 | 7 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 10 | S | SP | 1 | 8 | 2 |
| 5 | 28 | 16SEP82 | 7000 | 10 | S | SP | 1 | 9 | 1 |
| 5 | 28 | 16SEP82 | 7000 | 10 | 0 | PJ | 1 | 10 | 0 |
| 5 | 28 | 16SEP82 | 7000 | 10 | N | SB | 2 | 1 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | N | SB | 2 | 2 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | 0 | SB | 2 | 3 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 20 | NE | MB | 2 | 4 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 20 | SW | PJ | 2 | 5 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | N | SP | 2 | 6 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | N | SP | 2 | 7 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | N | MB | 2 | 8 | 5 |
| 5 | 28 | 16SEP82 | 6500 | 10 | 0 | MB | 2 | 9 | 0 |
| 5 | 28 | 16SEP82 | 6500 | 10 | N | SB | 2 | 10 | 1 |
| 5 | 29 | 17SEP82 | 7000 | 10 | W | SP | 1 | 1 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 20 | NW | OT | 1 | 2 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | N | SB | 1 | 3 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | 0 | SB | 1 | 4 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | 0 | SP | 1 | 5 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | N | SB | 1 | 6 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 20 | N | MB | 1 | 7 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 30 | SW | PJ | 1 | 8 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 20 | W | SP | 1 | 9 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 20 | W | SB | 1 | 10 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | 0 | SB | 2 | 1 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | N | SP | 2 | 2 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | W | SP | 2 | 3 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | N | SB | 2 | 4 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | N | SB | 2 | 5 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | NE | SB | 2 | 6 | 1 |
| 5 | 29 | 17SEP82 | 7000 | 20 | E | SB | 2 | 7 | 2 |
| 5 | 29 | 17SEP82 | 7000 | 10 | NE | SP | 2 | 8 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | NE | SB | 2 | 9 | 0 |
| 5 | 29 | 17SEP82 | 7000 | 10 | NE | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 36 | 17SEP82 | 6500 | 10 | 0 | SP | 1 | 1 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | NE | MP | 1 | 2 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 20 | S | SP | 1 | 3 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | SE | SP | 1 | 4 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | SE | MP | 1 | 5 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | E | SP | 1 | 6 | 0 |
| 5 | 36 | 17SEP82 | 7000 | 30 | N | MP | 1 | 7 | 0 |
| 5 | 36 | 17SEP82 | 7000 | 30 | S | MP | 1 | 8 | 0 |
| 5 | 36 | 17SEP82 | 7000 | 30 | S | MP | 1 | 9 | 0 |
| 5 | 36 | 17SEP82 | 7000 | 10 | S | MP | 1 | 10 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | S | MP | 2 | 1 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | S | SP | 2 | 2 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | NE | SP | 2 | 3 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | E | SP | 2 | 4 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | E | PJ | 2 | 5 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | E | SP | 2 | 6 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | SE | SP | 2 | 7 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | 0 | MP | 2 | 8 | 0 |
| 5 | 36 | 17SEP82 | 6500 | 10 | SE | SP | 2 | 9 | 0 |
| 5 | 36 | 17SEP82 | 7000 | 10 | SE | SP | 2 | 10 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 1 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | W | SP | 1 | 2 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | SE | MP | 1 | 3 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 4 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 5 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 6 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | NW | PJ | 1 | 7 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 20 | N | MP | 1 | 8 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 9 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 10 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | E | MP | 2 | 1 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | E | MP | 2 | 2 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | E | MP | 2 | 3 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | E | MP | 2 | 4 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 30 | E | SP | 2 | 5 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | N | MP | 2 | 6 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 2 | 7 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 2 | 8 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 2 | 9 | 0 |
| 6 | 8 | 22SEP82 | 6500 | 10 | 0 | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 11 | 23SEP82 | 6500 | 20 | N | MP | 1 | 1 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | MP | 1 | 2 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | SE | PJ | 1 | 3 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | S | MP | 1 | 4 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | SW | MP | 1 | 5 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | PJ | 1 | 6 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | SP | 1 | 7 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | SP | 1 | 8 | 1 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | MP | 1 | 9 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | N | MP | 1 | 10 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | SE | SP | 2 | 1 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | SP | 2 | 2 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | N | SP | 2 | 3 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | SE | MP | 2 | 4 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | N | PJ | 2 | 5 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 20 | E | MP | 2 | 6 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | SW | PJ | 2 | 7 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | SP | 2 | 8 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | SE | PJ | 2 | 9 | 0 |
| 6 | 11 | 23SEP82 | 6500 | 10 | 0 | SP | 2 | 10 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | E | MP | 1 | 1 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | SE | PJ | 1 | 2 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | 0 | PJ | 1 | 3 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 4 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 5 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 20 | NW | MP | 1 | 6 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 7 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 30 | SE | MP | 1 | 8 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 20 | SE | MP | 1 | 9 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 10 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | SP | 2 | 1 | 1 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | SP | 2 | 2 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | SP | 2 | 3 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | SP | 2 | 4 | 1 |
| 6 | 14 | 22SEP82 | 6500 | 30 | SE | SP | 2 | 5 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | 0 | SP | 2 | 6 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | MP | 2 | 7 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | MP | 2 | 8 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 20 | N | MP | 2 | 9 | 0 |
| 6 | 14 | 22SEP82 | 6500 | 10 | N | MP | 2 | 10 | 1 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 27 | 23SEP82 | 6500 | 30 | S | MP | 1 | 1 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 20 | E | SP | 1 | 2 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 30 | N | SP | 1 | 3 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 50 | S | MP | 1 | 4 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | E | SP | 1 | 5 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | SE | PJ | 1 | 6 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | E | PJ | 1 | 7 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | E | MP | 1 | 8 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 30 | S | MP | 1 | 9 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | NE | SB | 1 | 10 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 20 | SE | MB | 2 | 1 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | SE | MB | 2 | 2 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | SE | SB | 2 | 3 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 50 | S | OT | 2 | 4 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | E | SP | 2 | 5 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 20 | N | SP | 2 | 6 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | SE | SB | 2 | 7 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 30 | SW | MP | 2 | 8 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | E | SP | 2 | 9 | 0 |
| 6 | 27 | 23SEP82 | 6500 | 10 | N | SP | 2 | 10 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | 0 | MP | 1 | 1 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | SW | MP | 1 | 2 | 1 |
| 6 | 30 | 22SEP82 | 6500 | 10 | S | MP | 1 | 3 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | N | MP | 1 | 4 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | N | MP | 1 | 5 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | N | PJ | 1 | 6 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | N | SP | 1 | 7 | 1 |
| 6 | 30 | 22SEP82 | 6500 | 20 | NE | SB | 1 | 8 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 9 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 10 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 1 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 2 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 3 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | MP | 2 | 4 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | MP | 2 | 5 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | E | MP | 2 | 6 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | SE | MP | 2 | 7 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | 0 | PJ | 2 | 8 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | 0 | MP | 2 | 9 | 0 |
| 6 | 30 | 22SEP82 | 6500 | 10 | N | PJ | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 32 | 23SEP82 | 6500 | 30 | SE | SP | 1 | 1 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | N | SP | 1 | 2 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 50 | S | MP | 1 | 3 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | E | PJ | 1 | 4 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | E | SP | 1 | 5 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | NE | SP | 1 | 6 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | SE | PJ | 1 | 7 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 20 | NE | SP | 1 | 8 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 20 | E | PJ | 1 | 9 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | E | MP | 1 | 10 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | 0 | SB | 2 | 1 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 10 | SE | OT | 2 | 2 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 20 | SE | SP | 2 | 3 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | N | MP | 2 | 4 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | SW | SP | 2 | 5 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | W | MP | 2 | 6 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | W | MP | 2 | 7 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 30 | W | PJ | 2 | 8 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 20 | W | PJ | 2 | 9 | 0 |
| 6 | 32 | 23SEP82 | 6500 | 20 | SW | PJ | 2 | 10 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | W | SB | 1 | 1 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | E | SP | 1 | 2 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | E | SP | 1 | 3 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 20 | E | MP | 1 | 4 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 20 | E | MP | 1 | 5 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | E | MP | 1 | 6 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | 0 | PJ | 1 | 7 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 8 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 1 | 9 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | 0 | PJ | 1 | 10 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | 0 | MP | 2 | 1 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | W | PJ | 2 | 2 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 3 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 4 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 5 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 6 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 7 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 20 | N | MP | 2 | 8 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 20 | N | SP | 2 | 9 | 0 |
| 6 | 35 | 22SEP82 | 6500 | 10 | 0 | MP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 1 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 10 | NW | MB | 1 | 2 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 30 | SE | MB | 1 | 3 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 30 | SE | MB | 1 | 4 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 30 | SE | MB | 1 | 5 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 10 | 0 | MB | 1 | 6 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 10 | NW | MB | 1 | 7 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 8 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 9 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 10 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 0 | 0 | SB | 2 | 1 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 2 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 10 | NW | MB | 2 | 3 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 2 | 4 | 0 |
| 7 | 16 | 24SEP82 | 7500 | 20 | NW | MB | 2 | 5 | 0 |
| 7 | 16 | 24SEP82 | 7000 | 20 | NW | MB | 2 | 6 | 0 |
| 7 | 16 | 24SEP82 | 7000 | 10 | NW | MB | 2 | 7 | 0 |
| 7 | 16 | 24SEP82 | 7000 | 10 | S | SB | 2 | 8 | 0 |
| 7 | 16 | 24SEP82 | 7000 | 40 | E | MB | 2 | 9 | 0 |
| 7 | 16 | 24SEP82 | 7000 | 30 | SE | MB | 2 | 10 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | NW | MB | 1 | 1 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | N | MB | 1 | 2 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 20 | N | MB | 1 | 3 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 40 | S | MP | 1 | 4 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 10 | W | MB | 1 | 5 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 30 | NW | MB | 1 | 6 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 40 | NW | MB | 1 | 7 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 40 | N | MB | 1 | 8 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 50 | W | MB | 1 | 9 | 0 |
| 7 | 17 | 24SEP82 | 7000 | 40 | W | MB | 1 | 10 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 1 | 1 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 2 | 1 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 3 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 4 | 1 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 5 | 1 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 6 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | NW | MB | 2 | 7 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 8 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 9 | 0 |
| 7 | 17 | 24SEP82 | 7500 | 10 | NW | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 19 | 30SEP82 | 8000 | 30 | E | MB | 1 | 1 | 0 |
| 7 | 19 | 30SEP82 | 8000 | 30 | E | MB | 1 | 2 | 0 |
| 7 | 19 | 30SEP82 | 8000 | 40 | NE | OT | 1 | 3 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 40 | NE | OT | 1 | 4 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 10 | NE | OT | 1 | 5 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SW | MB | 1 | 6 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SW | MB | 1 | 7 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 20 | SW | MB | 1 | 8 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SW | MB | 1 | 9 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SW | MB | 1 | 10 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 50 | NW | OT | 2 | 1 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 50 | NW | OT | 2 | 2 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 40 | SE | OT | 2 | 3 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 50 | N | OT | 2 | 4 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 50 | N | OT | 2 | 5 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | S | MB | 2 | 6 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SE | MB | 2 | 7 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SE | MB | 2 | 8 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SE | MP | 2 | 9 | 0 |
| 7 | 19 | 30SEP82 | 7500 | 30 | SE | MP | 2 | 10 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | 0 | MB | 1 | 1 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | W | MB | 1 | 2 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NW | MB | 1 | 3 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | N | MB | 1 | 4 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 5 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 30 | NW | MB | 1 | 6 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 20 | N | MB | 1 | 7 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NW | MB | 1 | 8 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 20 | SE | MB | 1 | 9 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 20 | S | MB | 1 | 10 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 30 | E | MB | 2 | 1 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 20 | SE | MB | 2 | 2 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | SE | MB | 2 | 3 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | N | MB | 2 | 4 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 5 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 6 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 7 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 8 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 9 | 0 |
| 7 | 22 | 24SEP82 | 7500 | 10 | 0 | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 28 | 24SEP82 | 8000 | 30 | SE | MB | 1 | 1 | 0 |
| 7 | 28 | 24SEP82 | 8000 | 20 | SE | MB | 1 | 2 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 10 | SE | MB | 1 | 3 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 10 | N | MB | 1 | 4 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 20 | NW | MB | 1 | 5 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | NW | MB | 1 | 6 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | NW | MB | 1 | 7 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | NW | MB | 1 | 8 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | NW | MB | 1 | 9 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 10 | SE | SB | 1 | 10 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 50 | N | MB | 2 | 1 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 50 | N | MB | 2 | 2 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 50 | N | MB | 2 | 3 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 50 | E | MB | 2 | 4 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | N | MB | 2 | 5 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 40 | N | MB | 2 | 6 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 10 | SE | MB | 2 | 7 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 30 | SE | MB | 2 | 8 | 1 |
| 7 | 28 | 24SEP82 | 7500 | 30 | SE | MB | 2 | 9 | 0 |
| 7 | 28 | 24SEP82 | 7500 | 30 | SE | MB | 2 | 10 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 20 | NW | MB | 1 | 1 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | NW | MB | 1 | 2 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | NW | OT | 1 | 3 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | NW | OT | 1 | 4 | 1 |
| 7 | 32 | 24SEP82 | 8000 | 50 | SE | MB | 1 | 5 | 1 |
| 7 | 32 | 24SEP82 | 8000 | 50 | SE | MB | 1 | 6 | 1 |
| 7 | 32 | 24SEP82 | 8000 | 50 | SE | MB | 1 | 7 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 50 | SE | MB | 1 | 8 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 10 | 0 | MB | 1 | 9 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 10 | NW | MB | 1 | 10 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 20 | NW | MB | 2 | 1 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | NW | OT | 2 | 2 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | NW | OT | 2 | 3 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | S | OT | 2 | 4 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | E | MB | 2 | 5 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | N | OT | 2 | 6 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | NE | OT | 2 | 7 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | NE | OT | 2 | 8 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 40 | S | MB | 2 | 9 | 0 |
| 7 | 32 | 24SEP82 | 8000 | 30 | S | MB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 34 | 24SEP82 | 7500 | 50 | N | MB | 1 | 1 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | N | MB | 1 | 2 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | N | MB | 1 | 3 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 40 | SE | MB | 1 | 4 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | NE | MB | 1 | 5 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | SW | MB | 1 | 6 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | W | MB | 1 | 7 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | W | MB | 1 | 8 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | S | MB | 1 | 9 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 30 | NW | MB | 1 | 10 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | N | MB | 2 | 1 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | N | MB | 2 | 2 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | SE | MB | 2 | 3 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | SE | MB | 2 | 4 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | SE | MB | 2 | 5 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | E | MB | 2 | 6 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | E | MB | 2 | 7 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 50 | E | MB | 2 | 8 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 10 | E | MB | 2 | 9 | 0 |
| 7 | 34 | 24SEP82 | 7500 | 10 | NE | MB | 2 | 10 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | MB | 1 | 1 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 1 | 2 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 1 | 3 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | S | SB | 1 | 4 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | S | SB | 1 | 5 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 30 | NE | MP | 1 | 6 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 40 | S | PJ | 1 | 7 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 40 | E | PJ | 1 | 8 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | S | MP | 1 | 9 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | 0 | MP | 1 | 10 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 1 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 2 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 3 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 4 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 5 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 6 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 7 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 8 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 9 | 0 |
| 8 | 3 | 24SEP82 | 7000 | 10 | N | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 5 | 22SEP82 | 7000 | 10 | N | MB | 1 | 1 | 1 |
| 8 | 5 | 22SEP82 | 7000 | 10 | SE | SB | 1 | 2 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | SE | MB | 1 | 3 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 50 | SW | MB | 1 | 4 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | S | SP | 1 | 5 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 20 | SW | MB | 1 | 6 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | E | MB | 1 | 7 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 40 | E | MB | 1 | 8 | 1 |
| 8 | 5 | 22SEP82 | 7000 | 20 | SE | MP | 1 | 9 | 1 |
| 8 | 5 | 22SEP82 | 7000 | 10 | SE | SP | 1 | 10 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | N | SP | 2 | 1 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | N | SP | 2 | 2 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | N | SP | 2 | 3 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | NW | SP | 2 | 4 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | NE | SB | 2 | 5 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 30 | SW | SB | 2 | 6 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 40 | SE | MP | 2 | 7 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 20 | SE | PJ | 2 | 8 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 10 | E | MP | 2 | 9 | 0 |
| 8 | 5 | 22SEP82 | 7000 | 40 | E | PJ | 2 | 10 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | SE | MP | 1 | 1 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 20 | E | MP | 1 | 2 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 20 | SE | MB | 1 | 3 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 30 | SE | MP | 1 | 4 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 30 | S | MP | 1 | 5 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | S | SP | 1 | 6 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | N | SP | 1 | 7 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | N | SP | 1 | 8 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | N | SP | 1 | 9 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | N | MP | 1 | 10 | 0 |
| 8 | 11 | 22SEP82 | 6500 | 40 | NE | MB | 2 | 1 | 0 |
| 8 | 11 | 22SEP82 | 6500 | 50 | S | MP | 2 | 2 | 0 |
| 8 | 11 | 22SEP82 | 6500 | 40 | S | SP | 2 | 3 | 0 |
| 8 | 11 | 22SEP82 | 6500 | 40 | S | PJ | 2 | 4 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | SW | SP | 2 | 5 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | 0 | SP | 2 | 6 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | SE | SP | 2 | 7 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | E | SP | 2 | 8 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | SE | SP | 2 | 9 | 0 |
| 8 | 11 | 22SEP82 | 7000 | 10 | SE | SP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 13 | 23SEP82 | 7000 | 20 | SE | MB | 1 | 1 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | SP | 1 | 2 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 20 | SE | MP | 1 | 3 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 4 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 1 | 5 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | 0 | SB | 1 | 6 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | 0 | SB | 1 | 7 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | NW | SB | 1 | 8 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | NW | SB | 1 | 9 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | NW | SB | 1 | 10 | 1 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 2 | 1 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MP | 2 | 2 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 2 | 3 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 2 | 4 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 2 | 5 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | MB | 2 | 6 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | SB | 2 | 7 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | SE | SB | 2 | 8 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | S | MB | 2 | 9 | 0 |
| 8 | 13 | 23SEP82 | 7000 | 10 | 0 | MB | 2 | 10 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 1 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 2 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 3 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 4 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 5 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MP | 1 | 6 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MB | 1 | 7 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | SE | MB | 1 | 8 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | S | MB | 1 | 9 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 20 | S | MB | 1 | 10 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 40 | E | MB | 2 | 1 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 30 | E | MP | 2 | 2 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 20 | E | MP | 2 | 3 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 50 | S | MP | 2 | 4 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 40 | E | MP | 2 | 5 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 30 | E | MP | 2 | 6 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 50 | SE | MP | 2 | 7 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 20 | SE | MP | 2 | 8 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 20 | E | MP | 2 | 9 | 0 |
| 8 | 14 | 23SEP82 | 7000 | 10 | E | MP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 27 | 22SEP82 | 7000 | 30 | SW | MP | 1 | 1 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | NW | MP | 1 | 2 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 40 | NW | MP | 1 | 3 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 4 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | 0 | OT | 1 | 5 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | SE | SB | 1 | 6 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 50 | S | MP | 1 | 7 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | S | SP | 1 | 8 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | 0 | SP | 1 | 9 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | E | SP | 1 | 10 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | N | SB | 2 | 1 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 10 | N | SB | 2 | 2 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 20 | N | SB | 2 | 3 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 30 | E | MB | 2 | 4 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 50 | W | MP | 2 | 5 | 0 |
| 8 | 27 | 22SEP82 | 7000 | 30 | W | MP | 2 | 6 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 30 | N | SB | 2 | 7 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | 0 | OT | 2 | 8 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | 0 | OT | 2 | 9 | 0 |
| 8 | 27 | 22SEP82 | 6500 | 10 | 0 | OT | 2 | 10 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | 0 | SB | 1 | 1 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 1 | 2 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | 0 | OT | 1 | 3 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | NW | MB | 1 | 4 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | NW | MB | 1 | 5 | 1 |
| 8 | 34 | 22SEP82 | 7000 | 20 | NW | MB | 1 | 6 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 40 | NW | MB | 1 | 7 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 20 | NW | MB | 1 | 8 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 40 | E | SB | 1 | 9 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 20 | E | MP | 1 | 10 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 1 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 2 | 1 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 3 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 4 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 5 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 6 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 7 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 10 | N | SB | 2 | 8 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 20 | W | MP | 2 | 9 | 0 |
| 8 | 34 | 22SEP82 | 7000 | 20 | W | MP | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 3 | 22SEP82 | 6500 | 10 | E | PJ | 1 | 1 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | 0 | PJ | 1 | 2 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | NE | PJ | 1 | 3 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | NW | MP | 1 | 4 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | N | MP | 1 | 5 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | W | MP | 1 | 6 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | NW | SP | 1 | 7 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 30 | N | MP | 1 | 8 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | N | SB | 1 | 9 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | NW | SB | 1 | 10 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | E | SB | 2 | 1 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | E | SP | 2 | 2 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | E | PJ | 2 | 3 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 40 | S | MP | 2 | 4 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | E | SP | 2 | 5 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | E | SP | 2 | 6 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | NE | SP | 2 | 7 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | NE | MP | 2 | 8 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 20 | E | PJ | 2 | 9 | 0 |
| 9 | 3 | 22SEP82 | 6500 | 10 | N | SP | 2 | 10 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | N | MP | 1 | 1 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | N | MP | 1 | 2 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 30 | S | PJ | 1 | 3 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 4 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | N | SP | 1 | 5 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 40 | NE | MP | 1 | 6 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | N | MP | 1 | 7 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 30 | E | MP | 1 | 8 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | N | SB | 1 | 9 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 10 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 1 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 2 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | NW | MP | 2 | 3 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | NE | MP | 2 | 4 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | NE | MP | 2 | 5 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | E | MP | 2 | 6 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | N | MP | 2 | 7 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | N | MB | 2 | 8 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 10 | W | SB | 2 | 9 | 0 |
| 9 | 7 | 22SEP82 | 6500 | 20 | W | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 9 | 22SEP82 | 6500 | 10 | SW | SP | 1 | 1 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | NE | SP | 1 | 2 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | NE | SP | 1 | 3 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | SW | SB | 1 | 4 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 5 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 20 | SE | SB | 1 | 6 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 50 | E | MP | 1 | 7 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | E | MP | 1 | 8 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | E | MP | 1 | 9 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | NE | MP | 1 | 10 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | SW | SP | 2 | 1 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | SW | MP | 2 | 2 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 20 | SW | SP | 2 | 3 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 30 | NW | MP | 2 | 4 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 50 | SW | MP | 2 | 5 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 30 | NW | MP | 2 | 6 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 10 | NW | MP | 2 | 7 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 20 | N | MP | 2 | 8 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 20 | NW | MP | 2 | 9 | 0 |
| 9 | 9 | 22SEP82 | 6500 | 20 | NW | MP | 2 | 10 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SB | 1 | 1 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | N | SB | 1 | 2 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | N | SB | 1 | 3 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | NW | SB | 1 | 4 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 20 | SW | MB | 1 | 5 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | 0 | SB | 1 | 6 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | 0 | SP | 1 | 7 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | N | MB | 1 | 8 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | NE | SP | 1 | 9 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | N | MP | 1 | 10 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 1 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 2 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SP | 2 | 3 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 4 | 0 |
| 9 | 15 | 22SEP82 | 7000 | 10 | NW | SP | 2 | 5 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | NW | SP | 2 | 6 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 20 | N | SP | 2 | 7 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 20 | N | SB | 2 | 8 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | W | SB | 2 | 9 | 0 |
| 9 | 15 | 22SEP82 | 6500 | 10 | W | SB | 2 | 10 | 0 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 21 | 22SEP82 | 6500 | 50 | S | MB | 1 | 1 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 50 | SW | MP | 1 | 2 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 40 | S | MP | 1 | 3 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | S | MP | 1 | 4 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | 0 | SB | 1 | 5 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | 0 | SP | 1 | 6 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SB | 1 | 7 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | W | SB | 1 | 8 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | 0 | SB | 1 | 9 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SB | 1 | 10 | 0 |
| 9 | 21 | 22SEP82 | 6500 | 50 | E | MP | 2 | 1 | 0 |
| 9 | 21 | 22SEP82 | 6500 | 50 | E | MP | 2 | 2 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 40 | SE | MP | 2 | 3 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 30 | S | MP | 2 | 4 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 30 | SE | MP | 2 | 5 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | N | SP | 2 | 6 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SP | 2 | 7 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 8 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 9 | 0 |
| 9 | 21 | 22SEP82 | 7000 | 10 | NW | SB | 2 | 10 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | NW | MP | 1 | 1 | 0 |
| 9 | 30 | 22SEP82 | 6500 | 10 | N | MP | 1 | 2 | 0 |
| 9 | 30 | 22SEP82 | 6500 | 40 | S | PJ | 1 | 3 | 0 |
| 9 | 30 | 22SEP82 | 6500 | 10 | S | MP | 1 | 4 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | 0 | MP | 1 | 5 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | N | MP | 1 | 6 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | 0 | MP | 1 | 7 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | NE | MP | 1 | 8 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | NE | SP | 1 | 9 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | 0 | SP | 1 | 10 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | NW | MP | 2 | 1 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | NW | MP | 2 | 2 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 20 | NW | MP | 2 | 3 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | SW | MP | 2 | 4 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | 0 | PJ | 2 | 5 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | N | PJ | 2 | 6 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 10 | N | MP | 2 | 7 | 0 |
| 9 | 30 | 22SEP82 | 6500 | 40 | W | MB | 2 | 8 | 0 |
| 9 | 30 | 22SEP82 | 6500 | 10 | N | MP | 2 | 9 | 0 |
| 9 | 30 | 22SEP82 | 7000 | 20 | SW | MP | 2 | 10 | 0 |

RIC BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM - TRACT C-A

REPORT YEAR=1982  SEASON=SUMMER

| BLOCK | SAMPLE UNIT | DATE | ELEV | SLOPE | ASPECT | VEG TYPE | TRAN-SECT | PLOT | PELLET COUNT |
|---|---|---|---|---|---|---|---|---|---|
| 9 | 35 | 22SEP82 | 7000 | 10 | NW | SB | 1 | 1 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | NW | SP | 1 | 2 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 50 | S | MP | 1 | 3 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | W | MP | 1 | 4 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 20 | W | MP | 1 | 5 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | SW | MP | 1 | 6 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | W | PJ | 1 | 7 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | W | PJ | 1 | 8 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | SE | MP | 1 | 9 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | NW | PJ | 1 | 10 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | 0 | SP | 2 | 1 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 30 | NE | SP | 2 | 2 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 30 | NE | SP | 2 | 3 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 20 | NE | SB | 2 | 4 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 10 | N | SB | 2 | 5 | 0 |
| 9 | 35 | 22SEP82 | 6500 | 10 | NE | SP | 2 | 6 | 0 |
| 9 | 35 | 22SEP82 | 6500 | 20 | NE | SP | 2 | 7 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 40 | SW | MP | 2 | 8 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 40 | SW | MP | 2 | 9 | 0 |
| 9 | 35 | 22SEP82 | 7000 | 20 | N | MP | 2 | 10 | 0 |

# APPENDIX 3-2.2

## Analyses for Mule Deer Studies

Duncan's Multiple Range Test results on all winter mule deer pellet group counts.

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES
ONE-WAY ANALYSIS OF VARIANCE COMPARING BLOCKS
REPORT YEAR=1982

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=2511 MSE=0.239421

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | | MEAN | N | BLOCK |
|---|---|---|---|---|
| | A | 0.32500 | 280 | 5 |
| | A | | | |
| B | A | 0.24643 | 280 | 4 |
| B | | | | |
| B | | 0.23571 | 280 | 1 |
| | C | 0.14286 | 280 | 6 |
| | C | | | |
| D | C | 0.11429 | 280 | 7 |
| D | C | | | |
| D | C | 0.09286 | 280 | 2 |
| D | C | | | |
| D | C | 0.08929 | 280 | 8 |
| D | C | | | |
| D | C | 0.08571 | 280 | 3 |
| D | | | | |
| D | | 0.04643 | 280 | 9 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES
THREE-WAY MODEL I ANALYSIS OF VARIANCE
COMPARING REPORT YEAR, SEASON, AND BLOCK
IN THE MULE DEER DENSITY SAMPLING PROGRAM

ANALYSIS OF VARIANCE PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=12510 MSE=0.253449

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | RPTYR |
|---|---|---|---|
| A | 0.24841 | 2520 | 1978 |
| B | 0.20714 | 2520 | 1979 |
| C | 0.15317 | 2520 | 1982 |
| C | | | |
| C | 0.15000 | 2520 | 1980 |
| C | | | |
| C | 0.14405 | 2520 | 1981 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES
THREE-WAY MODEL I ANALYSIS OF VARIANCE
COMPARING REPORT YEAR, SEASON, AND BLOCK
IN THE MULE DEER DENSITY SAMPLING PROGRAM

ANALYSIS OF VARIANCE PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=12510 MSE=0.253449

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | BLOCK |
|---|---|---|---|
| A | 0.30429 | 1400 | 5 |
| B | 0.26071 | 1400 | 1 |
| C | 0.20929 | 1400 | 6 |
| C | | | |
| C | 0.20071 | 1400 | 4 |
| C | | | |
| C | 0.19786 | 1400 | 2 |
| D | 0.15429 | 1400 | 3 |
| D | | | |
| E D | 0.12643 | 1400 | 7 |
| E | | | |
| E F | 0.10357 | 1400 | 8 |
| F | | | |
| F | 0.06786 | 1400 | 9 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES
THREE-WAY MODEL I ANALYSIS OF VARIANCE
COMPARING REPORT YEAR, SEASON, AND BLOCK
IN THE MULE DEER DENSITY SAMPLING PROGRAM

ANALYSIS OF VARIANCE PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
NOTE: THIS TEST CONTROLS ERROR RATES AT DIFFERENT LEVELS
DEPENDING ON THE NUMBER OF MEANS BETWEEN EACH PAIR
BEING COMPARED. ITS OPERATING CHARACTERISTICS SOMEWHAT
RESEMBLE FISHER'S UNPROTECTED LSD TEST.
ALPHA=0.05 DF=12510 MSE=0.253449

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| DUNCAN GROUPING | MEAN | N | SEASON |
|---|---|---|---|
| A | 0.28841 | 6300 | WINTER |
| B | 0.07270 | 6300 | SUMMER |

Duncan's Multiple Range Test results for
deer density by site characteristics.

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = VEGETATION TYPE
RPTYR=1978 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=218 MSE=0.69
HARMONIC MEAN OF CELL SIZES=134.525
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | TYPE |
|---|---|---|---|
| A | 0.491758 | 364 | MIXED BRUSH |
| A | | | |
| A | 0.478673 | 211 | SAGEBRUSH/P. J. |
| A | | | |
| A | 0.422925 | 253 | SAGEBRUSH |
| A | | | |
| B A | 0.336996 | 273 | MIXED PINYON |
| B | | | |
| B | 0.200000 | 110 | PINYON JUNIPER |
| B | | | |
| B | 0.163265 | 49 | OTHER VEG TYPE |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = VEGETATION TYPE
RPTYR=1979 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=218 MSE=0.69
HARMONIC MEAN OF CELL SIZES=134.525
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | TYPE |
|---|---|---|---|
| A | 0.549451 | 273 | MIXED PINYON |
| B | 0.321429 | 364 | MIXED BRUSH |
| B | | | |
| B | 0.316206 | 253 | SAGEBRUSH |
| B | | | |
| B | 0.263636 | 110 | PINYON JUNIPER |
| B | | | |
| B | 0.246445 | 211 | SAGEBRUSH/P. J. |
| B | | | |
| B | 0.102041 | 49 | OTHER VEG TYPE |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = VEGETATION TYPE
RPTYR=1980  SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05  DF=218  MSE=0.69
HARMONIC MEAN OF CELL SIZES=134.525
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | TYPE |
|---|---|---|---|
| A | 0.278388 | 273 | MIXED PINYON |
| A A | 0.272727 | 253 | SAGEBRUSH |
| A A | 0.236264 | 364 | MIXED BRUSH |
| A A | 0.180095 | 211 | SAGEBRUSH/P. J. |
| A A | 0.100000 | 110 | PINYON JUNIPER |
| A | 0.061224 | 49 | OTHER VEG TYPE |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = VEGETATION TYPE
RPTYR=1981 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=218 MSE=0.69
HARMONIC MEAN OF CELL SIZES=134.525
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | TYPE |
|---|---|---|---|
| A | 0.335165 | 364 | MIXED BRUSH |
| A | | | |
| B A | 0.241758 | 273 | MIXED PINYON |
| B A | | | |
| B A | 0.177866 | 253 | SAGEBRUSH |
| B A | | | |
| B A | 0.156398 | 211 | SAGEBRUSH/P. J. |
| B | | | |
| B | 0.072727 | 110 | PINYON JUNIPER |
| B | | | |
| B | 0.061224 | 49 | OTHER VEG TYPE |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = VEGETATION TYPE
RPTYR=1982 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=218 MSE=0.69
HARMONIC MEAN OF CELL SIZES=134.127
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | TYPE |
|---|---|---|---|
| A | 0.326923 | 364 | MIXED BRUSH |
| A | | | |
| B A | 0.249012 | 253 | SAGEBRUSH |
| B A | | | |
| B A | 0.248175 | 274 | MIXED PINYON |
| B A | | | |
| B A | 0.226415 | 212 | SAGEBRUSH/P. J. |
| B A | | | |
| B A | 0.142857 | 49 | OTHER VEG TYPE |
| B | | | |
| B | 0.092593 | 108 | PINYON JUNIPER |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ELEVATION
RPTYR=1978 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=199 MSE=0.54
HARMONIC MEAN OF CELL SIZES=33.1294
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | ELEV |
|---|---|---|---|
| A | 0.426966 | 267 | 7500 |
| A | | | |
| A | 0.410569 | 492 | 6500 |
| A | | | |
| A | 0.409611 | 437 | 7000 |
| A | | | |
| A | 0.232143 | 56 | 8000 |
| A | | | |
| A | 0.125000 | 8 | 6000 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ELEVATION
RPTYR=1979 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=199 MSE=0.54
HARMONIC MEAN OF CELL SIZES=33.1296
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | ELEV |
|---|---|---|---|
| A | 0.500000 | 8 | 6000 |
| A<br>A | 0.381279 | 438 | 7000 |
| A<br>A | 0.366599 | 491 | 6500 |
| A<br>A | 0.262172 | 267 | 7500 |
| A<br>A | 0.214286 | 56 | 8000 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ELEVATION
RPTYR=1980 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=199 MSE=0.54
HARMONIC MEAN OF CELL SIZES=33.1294
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | ELEV |
|---|---|---|---|
| A | 0.375000 | 8 | 6000 |
| A | | | |
| A | 0.276888 | 437 | 7000 |
| A | | | |
| A | 0.217480 | 492 | 6500 |
| A | | | |
| A | 0.187266 | 267 | 7500 |
| A | | | |
| A | 0.035714 | 56 | 8000 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ELEVATION
RPTYR=1981 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=199 MSE=0.54
HARMONIC MEAN OF CELL SIZES=33.1294
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | ELEV |
|---|---|---|---|
| A | 0.340824 | 267 | 7500 |
| A<br>A | 0.321429 | 56 | 8000 |
| A<br>A | 0.250000 | 8 | 6000 |
| A<br>A | 0.212815 | 437 | 7000 |
| A<br>A | 0.148374 | 492 | 6500 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ELEVATION
RPTYR=1982 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=199 MSE=0.54
HARMONIC MEAN OF CELL SIZES=33.1294
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | ELEV |
|---|---|---|---|
| A | 0.315789 | 437 | 7000 |
| A | | | |
| A | 0.299625 | 267 | 7500 |
| A | | | |
| A | 0.250000 | 56 | 8000 |
| A | | | |
| A | 0.166667 | 492 | 6500 |
| A | | | |
| A | 0.125000 | 8 | 6000 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ASPECT (DIRECTION)
RPTYR=1978 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=333 MSE=0.69
HARMONIC MEAN OF CELL SIZES=110.956
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | DIRECT |
|---|---|---|---|
| A | 0.600000 | 280 | 360 |
| A | | | |
| B A | 0.470588 | 68 | 45 |
| B A | | | |
| B A | 0.402367 | 169 | 135 |
| B A | | | |
| B A | 0.371585 | 183 | 0 |
| B A | | | |
| B A | 0.370629 | 143 | 90 |
| B A | | | |
| B A | 0.355072 | 138 | 315 |
| B | | | |
| B | 0.280822 | 146 | 180 |
| B | | | |
| B | 0.232877 | 73 | 225 |
| B | | | |
| B | 0.216667 | 60 | 270 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ASPECT (DIRECTION)
RPTYR=1979 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=333 MSE=0.69
HARMONIC MEAN OF CELL SIZES=110.21
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | | | MEAN | N | DIRECT |
|---|---|---|---|---|---|
| | A | | 0.524476 | 143 | 90 |
| | A | | | | |
| B | A | | 0.434783 | 138 | 315 |
| B | A | | | | |
| B | A | C | 0.347518 | 282 | 360 |
| B | A | C | | | |
| B | A | C | 0.328767 | 146 | 180 |
| B | A | C | | | |
| B | A | C | 0.323529 | 68 | 45 |
| B | A | C | | | |
| B | A | C | 0.307692 | 169 | 135 |
| B | A | C | | | |
| B | A | C | 0.289617 | 183 | 0 |
| B | | C | | | |
| B | | C | 0.219178 | 73 | 225 |
| | | C | | | |
| | | C | 0.155172 | 58 | 270 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ASPECT (DIRECTION)
RPTYR=1980 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=333 MSE=0.69
HARMONIC MEAN OF CELL SIZES=110.956
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | DIRECT |
|---|---|---|---|
| A | 0.275000 | 280 | 360 |
| A<br>A | 0.258741 | 143 | 90 |
| A<br>A | 0.254438 | 169 | 135 |
| A<br>A | 0.217391 | 138 | 315 |
| A<br>A | 0.213115 | 183 | 0 |
| A<br>A | 0.212329 | 146 | 180 |
| A<br>A | 0.176471 | 68 | 45 |
| A<br>A | 0.136986 | 73 | 225 |
| A<br>A | 0.066667 | 60 | 270 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ASPECT (DIRECTION)
RPTYR=1981 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=333 MSE=0.69
HARMONIC MEAN OF CELL SIZES=110.956
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | DIRECT |
|---|---|---|---|
| A | 0.356643 | 143 | 90 |
| A | | | |
| A | 0.343195 | 169 | 135 |
| A | | | |
| A | 0.279412 | 68 | 45 |
| A | | | |
| A | 0.195652 | 138 | 315 |
| A | | | |
| A | 0.192857 | 280 | 360 |
| A | | | |
| A | 0.158470 | 183 | 0 |
| A | | | |
| A | 0.157534 | 146 | 180 |
| A | | | |
| A | 0.123288 | 73 | 225 |
| A | | | |
| A | 0.116667 | 60 | 270 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = ASPECT (DIRECTION)
RPTYR=1982 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=333 MSE=0.69
HARMONIC MEAN OF CELL SIZES=110.589
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | DIRECT |
|---|---|---|---|
| A | 0.343195 | 169 | 135 |
| A | | | |
| A | 0.307692 | 143 | 90 |
| A | | | |
| A | 0.291815 | 281 | 360 |
| A | | | |
| A | 0.235294 | 68 | 45 |
| A | | | |
| A | 0.219178 | 73 | 225 |
| A | | | |
| A | 0.203390 | 59 | 270 |
| A | | | |
| A | 0.196721 | 183 | 0 |
| A | | | |
| A | 0.181159 | 138 | 315 |
| A | | | |
| A | 0.178082 | 146 | 180 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = SLOPE OF TERRAIN
RPTYR=1978 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=332 MSE=0.69
HARMONIC MEAN OF CELL SIZES=120.222
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | SLOPE |
|---|---|---|---|
| A | 0.504854 | 206 | 20 |
| A A | 0.416237 | 776 | 10 |
| B A A | 0.385185 | 135 | 30 |
| B A | 0.266667 | 75 | 40 |
| B C | 0.147059 | 68 | 50 |
| C C | | | |
| C | | | |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = SLOPE OF TERRAIN
RPTYR=1979 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=332 MSE=0.69
HARMONIC MEAN OF CELL SIZES=120.285
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | | MEAN | N | SLOPE |
|---|---|---|---|---|
| | A | 0.458937 | 207 | 20 |
| | A | | | |
| B | A | 0.373333 | 75 | 40 |
| B | A | | | |
| B | A | 0.330323 | 775 | 10 |
| B | A | | | |
| B | A | 0.318519 | 135 | 30 |
| B | | | | |
| B | | 0.161765 | 68 | 50 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = SLOPE OF TERRAIN
RPTYR=1980 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=332 MSE=0.69
HARMONIC MEAN OF CELL SIZES=120.222
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | SLOPE |
|---|---|---|---|
| A | 0.315534 | 206 | 20 |
| A | | | |
| A | 0.228093 | 776 | 10 |
| A | | | |
| A | 0.214815 | 135 | 30 |
| A | | | |
| A | 0.088235 | 68 | 50 |
| A | | | |
| A | 0.080000 | 75 | 40 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = SLOPE OF TERRAIN
RPTYR=1981 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=332 MSE=0.69
HARMONIC MEAN OF CELL SIZES=120.285
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | | MEAN | N | SLOPE |
|---|---|---|---|---|
| | A | 0.355556 | 135 | 30 |
| | A | | | |
| B | A | 0.246377 | 207 | 20 |
| B | A | | | |
| B | A | 0.202581 | 775 | 10 |
| B | A | | | |
| B | A | 0.200000 | 75 | 40 |
| B | | | | |
| B | | 0.088235 | 68 | 50 |

RIO BLANCO OIL SHALE COMPANY
WILDLIFE MONITORING PROGRAM
MULE DEER DENSITY STUDIES

DUNCANS MULTIPLE RANGE TEST FOR PELLET GROUP DESCRIPTORS
DESCRIPTOR = SLOPE OF TERRAIN
RPTYR=1982 SEASON=WINTER

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: PELLET
PELLET COUNT
ALPHA=0.05 DF=332 MSE=0.69
HARMONIC MEAN OF CELL SIZES=120.222
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

| GROUPING | MEAN | N | SLOPE |
|---|---|---|---|
| A | 0.325243 | 206 | 20 |
| A A | | | |
| A | 0.274074 | 135 | 30 |
| A A | | | |
| A | 0.238402 | 776 | 10 |
| A A | | | |
| A | 0.213333 | 75 | 40 |
| A A | | | |
| A | 0.147059 | 68 | 50 |

# APPENDIX 3-2.3

## Mule Deer Road Kill Studies

RIO BLANCO OIL SHALE COMPANY
DEER ROAD KILL INFORMATION

| DATE | MILE MARKER | AGE | SEX | NO. KILLED |
|---|---|---|---|---|
| 16JAN79 | 4 | ADULT | MALE | 1 |
| 19FEB79 | 2.2 | ADULT | FEMALE | 1 |
| 21FEB79 | 12.6 | FAWN | FEMALE | 1 |
| 21FEB79 | 12.6 | FAWN | MALE | 1 |
| 22FEB79 | 0.7 | ADULT | FEMALE | 1 |
| 01MAR79 | 5.8 | ADULT | FEMALE | 1 |
| 11MAR79 | 9.8 | ADULT | MALE | 1 |
| 15MAR79 | 9.1 | ADULT | MALE | 1 |
| 06APR79 | 8 | ADULT | FEMALE | 1 |
| 26OCT79 | 12.8 | ADULT | FEMALE | 1 |
| 15DEC79 | 2.3 | FAWN | FEMALE | 1 |
| 21DEC79 | 5.1 | FAWN | FEMALE | 1 |
| 18JAN80 | 11.6 | ADULT | FEMALE | 1 |
| 20JAN80 | 12.9 | ADULT | FEMALE | 1 |
| 23JAN80 | 12.2 | ADULT | FEMALE | 1 |
| 30JAN80 | 4.8 | FAWN | FEMALE | 1 |
| 01FEB80 | 5.9 | ADULT | FEMALE | 1 |
| 21MAR80 | 4.7 | FAWN | MALE | 1 |
| 27MAR80 | 1.8 | ADULT | FEMALE | 1 |
| 07APR80 | 5.7 | FAWN | MALE | 1 |
| 29APR80 | 12.2 | ADULT | FEMALE | 1 |
| 17OCT80 | 7.8 | ADULT | FEMALE | 1 |
| 21NOV80 | 4.8 | ADULT | FEMALE | 1 |
| 09DEC80 | 5.3 | ADULT | FEMALE | 1 |
| 09DEC80 | 3.5 | ADULT | MALE | 1 |
| 05FEB81 | 4.9 | UNDETERMINED | UNDETERMINED | 1 |
| 16FEB81 | 5.2 | ADULT | FEMALE | 1 |
| 22MAR81 | 7.6 | ADULT | MALE | 1 |
| 14APR81 | 12.1 | ADULT | FEMALE | 1 |
| 19APR81 | 4.9 | UNDETERMINED | UNDETERMINED | 1 |
| 21OCT81 | 13.1 | FAWN | FEMALE | 1 |
| 02NOV81 | 3.5 | ADULT | FEMALE | 1 |
| 10NOV81 | 5.7 | FAWN | MALE | 1 |
| 24NOV81 | 12.6 | FAWN | FEMALE | 1 |
| 06DEC81 | 0.7 | FAWN | MALE | 1 |
| 11APR82 | 11.6 | ADULT | FEMALE | 1 |

APPENDIX 3-2.4

Feral Horse Observations During 1982

RIO BLANCO OIL SHALE COMPANY
FERAL HORSE COUNT INFORMATION

| MONTH | YEAR | TOWNSHIP | RANGE | SECTION | QUARTER SECTION | NO. OBSERVED |
|---|---|---|---|---|---|---|
| JANUARY | 1982 | 01S | 099W | 31 | NW | 6 |
| JANUARY | 1982 | 02S | 099W | 16 | NE | 4 |
| JANUARY | 1982 | 02S | 099W | 21 | SE | 10 |
| JANUARY | 1982 | 02S | 100W | 25 | SW | 4 |